DOCUMENT RESUME

ED 158 999 SE 024 738

TITLE	Using Pesticides: Private Applicator Manual, Texas.
INSTITUTION	Texas A and M Univ., College Station. Texas Agricultural Extension Service.
REPORT NO	MP-1289
PUB DATE	[77]
NOTE	47p.; For related document, see SE 024 739; Pesticide labels will not reproduce well; Contains occasional small print
EDRS PRICE	MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS	*Agricultural Production; *Disease Control; Entomology; Equipment; *Instructional Materials; *Job Skills; *Legislation; *Pesticides; Public Health; *Safety
IDENTIFIERS	Pest Control; Texas

ABSTRACT

This manual is designed by the Texas Department of Agriculture as a training program for private pesticide applicators to certify them on a voluntary basis, and to apply restricted-use pesticides in compliance with federal law. An introduction with federal and state laws and regulations regarding pesticide use and private applicators is presented. Topics discussed include labels and labelling, pesticide safety, environmental considerations, application equipment and calibration. The manual also presents pests and pest damage, insect pests, plant disease control, weed control, brush control, aquatic vegetation control, and wildlife damage control. (HM)

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MP-1289

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Using Pesticides

Private Applicator Manual

Texas

SE 024 138

Texas Agricultural Extension Service · The Texas A&M University System

Daniel C. Pfannstiel, Director · College Station, Texas

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LAWS AND REGULATIONS

Significant changes in federal and state laws affect you as a private pesticide applicator. For the first time, federal law regulates pesticide use. State law, once regulating only herbicide use in certain counties, now likewise regulates all pesticide use. Some of the changes will be discussed briefly; however, as a pesticide applicator you may want to become familiar with all provisions of these new laws.

The Federal Insecticide, Fungicide, and Rodenticide Act, known as FIFRA and first passed in 1947, was amended significantly in 1972 by the Federal Environmental Pesticide Control Act. The act was amended further in November 1975. The act is administered and enforced by the Environmental Protection Agency (EPA).

A pesticide is defined by law as any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest and any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant. Pesticides commonly used in agriculture include insecticides, fungicides, herbicides and harvest-aid chemicals.

Pesticides sold, offered for sale, distributed or delivered for transportation or transported within the state must be registered with the Texas Department of Agriculture and the EPA. Federal registration applies within the state, but additional state and local restrictions may exist.

Federal law requires EPA to classify each use of a pesticide as either "restricted" or "general," based on considerations of potential hazard to the applicator or other persons and the possibility of unreasonable adverse effect on the environment. A federally restricted-use pesticide may be used only by or under the direct supervision of a certified applicator. The state may further restrict additional uses to certified commercial and noncommercial applicators or impose other restrictions.

Among other features, the Texas Pesticide Control Act requires the certification of commercial and noncommercial applicators. The state law also provides that the Commissioner of Agriculture may adopt lists of state-limited-use pesticides. Except for use by a private applicator, the state-limited-use pesticide is limited to use by or under the direct supervision of certified commercial or noncommercial applicators.

The Texas Department of Agriculture is the state's lead agency for developing and implementing the State of Texas Plan for certification of pesticide applicators as required by federal law.

As defined by law, a private applicator applies or supervises the use of restricted-use pesticides on property owned or rented by him for the purpose of producing an agricultural commodity or on the property of another producer of an agricultural commodity in exchange for services only. A commercial pesticide

applicator is a person in the business of applying or supervising the use of a restricted-use or state-limited-use pesticide on the property of another for hire or compensation. A third type of certified applicator as established by the Texas Pesticide Control Act is the noncommercial applicator. This is "a person or government agency or department which wants to use restricted-use or state-limited-use pesticides or the authority to demonstrate restricted-use or state-limited-use pesticides and does not qualify as a private applicator and is not required to have a commercial applicator license."

Federal regulation requires that private applicator certification be based on practical knowledge of pest problems and control practices associated with his agricultural operations including proper storage, use, handling and disposal of the pesticides and containers and his related legal responsibility. The practical knowledge includes ability to:

- Recognize common pests and the damage caused by them.
- Read and understand the label and labeling information, including the common name of the pesticide to be applied, pest to be controlled, application timing and methods, safety precautions, any preharvest or reentry provisions and any specific disposal procedures.
- Apply pesticides in accordance with label instructions and warnings, including the ability to prepare the proper pesticide concentration under particular circumstances considering area to be covered, speed at which application equipment will be driven and the quantity dispersed in a given period.
- Recognize local environmental situations that must be considered during application to avoid contamination.
- Recognize poisoning symptoms and procedures to follow in the case of a pesticide accident.

A private applicator is not required by Texas law to have a license or be certified to use restricted-use pesticides or state-limited-use pesticides. However, the Commissioner of Agriculture is authorized to establish a program to certify private applicators, on a voluntary basis, who wish to apply restricted-use pesticides in compliance with federal law.

Private applicators in Texas under a program established by the Texas Department of Agriculture, and as specified in the State of Texas Plan for certification of pesticide applicators, may become eligible for certification on a voluntary basis in one of the following ways:

- Completing an approved training plan conducted by a qualified institution or training group;
- Submitting a completed questionnaire to the Texas Department of Agriculture following review of self-study material available through the Texas Agricultural Extension Service; or

- For emergency situations, a single-product, single-purchase, single-use certification is available through the Texas Department of Agriculture. Persons seeking a single-product, single-purchase, single-use certification should contact personnel of the Texas Department of Agriculture, the Texas Agricultural Extension Service or an approved dealer.

The Texas Agricultural Extension Service provides this training program for private applicator certification with the approval of the Texas Department of Agriculture so that a person can voluntarily meet the federal certification requirement.

Application of a restricted-use pesticide may be made by an individual under the direct supervision of a certified private applicator. Direct supervision is defined by EPA as including verifiable instruction with detailed guidance for applying the pesticide properly and provisions for contacting the certified applicator in the event he is needed. In some situations, as required by the label, the actual physical presence of the certified private applicator may be required.

Among federal and state requirements is the provision that use inconsistent with the label directions is a violation of the law and may subject the user to penalties.

Penalties for private applicators under the Federal Insecticide, Fungicide, and Rodenticide Act, subsequent to receiving a written warning from EPA or following a citation for a prior violation, may be a civil penalty of up to $1,000. Knowingly violating provisions of FIFRA is a misdemeanor. Upon conviction, a private applicator is subject to a fine of not more than $1,000 or imprisonment for not more than 30 days or both.

Penalties under the Texas Pesticide Control Act may include, upon conviction, a fine of up to $200, the maximum penalty for a Class C misdemeanor. Each violation is a separate offense.

The Texas Herbicide Law regulates the sale of, and in some counties the use of, hormone-type herbicides. Permits are required in regulated counties for applying hormone-type herbicides on 10 or more acres.

A tolerance, usually expressed in parts per million, is that amount of pesticide that may safely remain in or on a raw agricultural commodity. Enforcement of tolerances is the responsibility of the Food and Drug Administration (FDA) under the authority of the Food, Drug, and Cosmetic Act and of the Texas Department of Health Resources under the authority of the State Food, Drug, and Cosmetic Act.

The federal enforcement of tolerances for residues in meat and meat products is the responsibility of the Meat Inspection Division of the United States Department of Agriculture. A pesticide used

consistent with the label directions will result in a chemical residue, if any, within the established tolerance.

Abiding by the law is everyone's responsibility. It assures continued availability of pesticides and protects people and the environment.

We have briefly considered some of the legal responsibilities of the certified private applicator. A copy of the Texas Pesticide Control Act and Regulations is included in the packet of material you received.

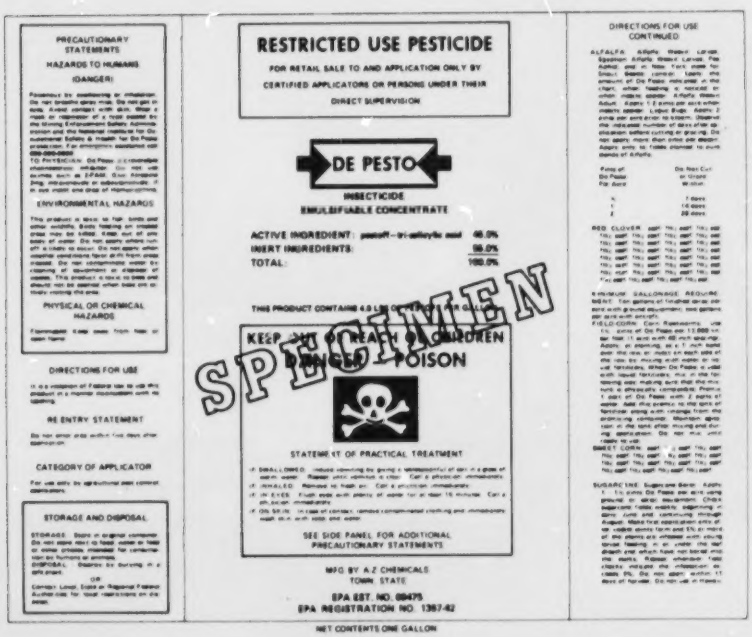
LABELS AND LABELING

Federal regulations also require private applicators to have a practical knowledge of pesticide labels and labeling.

A pesticide label is an end product of discovery, research, development and the federal and state registration process. Labeling requirements are part of registering a pesticide with EPA and the Texas Department of Agriculture. Federal law defines the label as the written, printed or graphic matter on, or attached to, the pesticide or any of its containers or wrappers.

Labeling includes the label and other information such as brochures, flyers and other materials referenced on the label or accompanying the label at any time.

What can we learn from the pesticide label? Certain information and its placement on the label is required by law. The product or brand name generally is the most prominent wording on the label.



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The active ingredient is identified by common or chemical name, or both, along with the amount. The active ingredient prevents or destroys pests and is primarily responsible for the desired effect. A product may contain more than one active ingredient. The remaining ingredients are collectively called inert ingredients. Such a mixture is generally called a formulation.

The active ingredient and the total of the inert ingredients are given by percentages. Additional information may be provided regarding the active ingredient such as the number of pounds of active ingredient per gallon of formulation.

Net contents must be shown in U.S. units and may also be given in metric units.

The label also must include the EPA registration number and an EPA establishment number. The latter number identifies the factory that made the product. The company's name and address also must appear on the label.

Thus far we have considered information relating to product identity. Labels tell us a lot more — things we need to know if we are to use a product effectively — including directions for use, statement of classification, physical or chemical hazards, environmental hazards, hazards to humans and domestic animals, a statement of practical treatment, a signal word and precautionary statements.

Pesticides are toxic. An estimate of the product's toxicity is provided by signal words. The signal word "DANGER" identifies a highly toxic product.

Highly toxic pesticide products also must carry the skull-and-crossbones symbol. If a product is highly toxic as evidenced by the signal word "DANGER," a section informing physicians of the proper treatment for poisoning is included on the label.

The signal word "WARNING" is required on all products that are moderately toxic as the term is defined by EPA regulations.

The signal word "CAUTION" is required on all products of low order toxicity. Toxicity is reflected by the signal word on the label. Remember the signal word meanings.

DANGER means HIGHLY TOXIC

WARNING means MODERATELY TOXIC

CAUTION means LOW ORDER OF TOXICITY

The words "Keep out of reach of children" are required on all products. A statement of practical treatment must appear on the label of all products requiring signal word labeling. The label is a prime source of instructions for first aid treatment for poisoning.

PRECAUTIONARY STATEMENTS

DANGER

HAZARDS TO HUMANS
(& DOMESTIC ANIMALS)

Poisonous by swallowing or inhalation. Do not breathe spray mist. Do not get in eyes. Avoid contact with skin. Wear a mask or respirator of a type passed by the U. S. Bureau of Mines for De Pesto protection. For emergency assistance call 000-000-0000
TO PHYSICIAN: De Pesto is a reversible cholinesterase inhibitor. Do not use oximes such as 2-PAM. Give Atropine 2mg. intravenously or subcutaneously. If in eye instill one drop of Homatrophine.

RESTRICTED USE PESTICIDE

FOR RETAIL SALE TO AND APPLICATION ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION

DIRECTIONS FOR
RESTRICTED USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

RE-ENTRY STATEMENT

Precautionary statements cover hazards to humans and domestic animals, environmental hazards and physical or chemical hazards. These statements describe how the product may be poisonous to man and animals and any special care necessary to avoid poisoning, such as the kind of protective equipment needed.

Environmental hazard information includes special precautions for using a product to minimize undesirable effects on the environment, for example, some products are labeled "This product is highly toxic to bees." Another typical environmental hazard caution calls attention to the special sensitivities of fish and wildlife.

The physical and chemical hazard statement lists any special fire, explosion or chemical hazards associated with the product.

Every insecticide label must show whether the contents are for general or restricted use. A restricted-use pesticide is one which could cause injury to the applicator or unreasonable adverse effects on the environment. The label on these products will read "Restricted-use pesticide for retail sale to and application only by certified applicators or persons under their direct supervision." The label of products other than restricted use will carry the words "General Classification."

The information essential for proper use of the product appears as directions regarding:

- The crop, animal or site to which the product is to be applied
- The specific pest or pests controlled by the product
- The situation, location and conditions under which the product should be used
- Rate and equipment requirements
- How to apply the product
- When to apply the product

This section of the pesticide label also includes limitations, such as those relating to reentry.

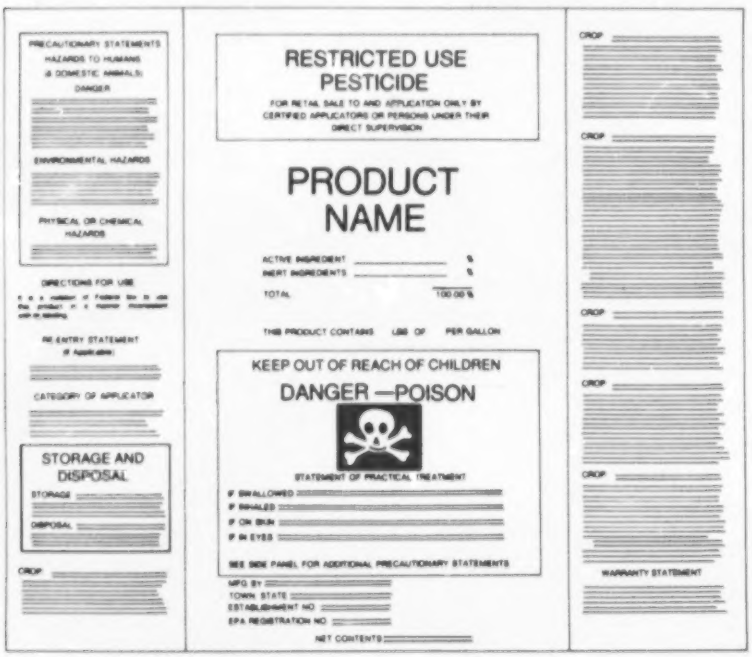
There are federal regulations establishing reentry times to be observed with certain pesticides and establishing certain procedures for warning workers before treating fields. These reentry times are to be observed unless the label specifies a longer interval between application and reentry in which case the label restriction is to be observed.

Another common limitation statement is the number of days between application and harvest or other uses such as grazing. In the case of livestock and poultry, the limitation may specify the time between the last application of a pesticide and marketing for slaughter or possibly a limitation with regard to marketing milk.

Storage and disposal instructions are required as part of the label. The rinse and drain procedure is recommended to reduce the amount of the product remaining in the container.

Part or all of the pesticide label may be written in other languages; the same label requirements apply regardless of language.

The label includes product identity information, directions for use and various precautionary statements, all of which are essential for proper and safe use. Remember the prime source of information about a pesticide product and its use is the label.



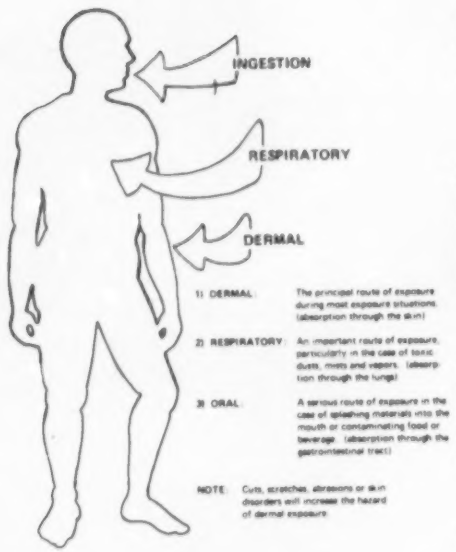
PESTICIDE SAFETY

A knowledge of proper storage, use, handling and disposal techniques and recognition of poisoning symptoms and procedures to follow in the case of pesticide poisoning are essential elements of safe use. These subjects, a part of the federal regulatory requirement, are included in this review of pesticide safety.

The importance of the product label as an information source is a key element of all aspects of safe use. Precautionary statements; hazards to man, domestic animals and the environment; reentry statements and storage and disposal information, all a part of the label, are a guide to safe use.

There are few safety recommendations that cover all situations; there are, however, some general guidelines that if followed along with the information on the product label will help when using pesticides. Here are some points worth remembering.

Chemicals used as pesticides are poisonous. Use caution to avoid accidental poisoning, damage or irritation to the skin or eyes and damage to crops, livestock and the environment. Safe


INGESTION
RESPIRATORY
DERMAL
1) DERMAL: The principal route of exposure during most exposure situations. (absorption through the skin)
2) RESPIRATORY: An important route of exposure, particularly in the case of toxic dusts, mists and vapors. (absorption through the lungs)
3) ORAL: A serious route of exposure in the case of splashing materials into the mouth or contaminating food or beverage. (absorption through the gastrointestinal tract)
NOTE: Cuts, scratches, abrasions or skin disorders will increase the hazard of dermal exposure.

use of a pesticide begins with purchase, continues through proper use and is complete with proper disposal of waste and the used container.

The key to preventing accidental pesticide poisoning is an awareness of the routes by which pesticides may enter the body. The hazard of pesticide use depends on the product's toxicity and the degree of exposure to it. Safety instructions on the label and from other sources become more meaningful if one is aware of the reasons for the instructions.

Pesticides may enter the body through the skin, lungs and mouth. Entry through the skin is the most likely source of poisoning during handling and use. Contact of the pesticides with the skin through spills, spray droplets, dusts or from equipment are all possible sources of skin absorption.

Mixers, loaders and flaggers are subject to relatively high levels of skin exposure. Although not minimizing the importance of protective measures during all work activities, the mixing and loading operation warrants special attention and care. Indoor spraying can be extremely hazardous because of the possibility of increased skin exposure. Poisoning from contact with treated plant surfaces has been reported. Hand harvesting, thinning, cultivating, irrigating and insect scouting can result in skin exposure.

Pesticide exposure of the skin is minimized through the use of protective equipment. Check the label for specific recommendations for protective clothing and equipment.

As a general rule, use clean clothing daily and cover up before exposure, not after. Covering contaminated skin can increase absorption of some pesticides. A long sleeved shirt and full length trousers or coverall-type garment made of closely woven material are minimum requirements.

A wide brimmed hat, preferably waterproof, will offer protection from downward drift to face and neck areas. Plastic "hard hats" are also useful. Contaminated hatbands can be a source of exposure. Use disposable hatbands or hatbands that can be cleaned readily.

Wear unlined, natural rubber gloves for best protection. For some pesticides, such as methyl bromide, gloves are not to be used. This is but one more example of the need for consulting the product label before using a pesticide. Prevent contamination of the inside of the gloves. Loose long sleeves should cover the gauntlet of the gloves to keep pesticides from running down the sleeves into the gloves.

If exposure to the lower trunk and legs is anticipated, such as in mixing and loading, a waterproof apron is essential. Waterproof shoes or boots are preferred. Leather shoes crack after a few

wettings and, thus, are penetrated easily. Canvas shoes offer little protection. Contaminated shoes or boots provide an exposure source. Wear trouser legs over boots to keep pesticides from running down the trousers into the boots.

Shield the eyes to avoid exposure, particularly if splashing may occur as in mixing and loading. Goggles or a face shield will provide protection.

If clothes become wet with spray or if the pesticide is splashed onto clothing or the skin, remove the clothing and wash immediately with soap and water. Skin decontamination is more efficient if done promptly. Heavily contaminated clothing should be destroyed. Do not store or wash contaminated clothing with the family laundry.

Proper care of protective clothing is essential. Test gloves for leaks. Wash gloves, boots, hat, goggles and face shield following each day's use and more often if necessary because of excessive contamination.

A pesticide may also enter the body through the lungs. The mouth is another point of entry followed by absorption through the gastrointestinal tract. While exposure through these routes is generally less than skin exposure, the pesticide is much more efficiently absorbed through these routes.

Respiratory protection can be provided by various types of respirators. Most respirators are air purifying and remove contaminants from air by filtering or chemical action.

Filters remove particles by physical trapping as air is inhaled. Mechanical filters do not provide protection against gases, vapors or oxygen deficiency.

Respirators usually contain a cartridge or cannister with a chemical that removes gases or vapors.

Read the label. If a respirator is required, the information will appear on the label. During fumigation or application of highly toxic pesticides in confined spaces, a respirator with a special compressed air supply tank is suggested.

No matter how well a respiratory device is designed and made, unless it is maintained properly, it may fail to provide protection. The two most common problems are (1) failure to occasionally wash the face piece with soap and water and (2) neglecting to change the filter cartridges. Check the face piece for cracks, hardening and elasticity of straps. A good seal is essential. Change the filters twice a day and whenever breathing becomes difficult. Change cartridges after 8 hours of actual use and whenever any pesticide odor is detected.

Remove filters and cartridges and wash the face piece with soap and warm water after use. Rinse thoroughly to remove traces of soap.

Dry with a clean cloth that is not contaminated with the pesticide. Place the face piece in a well-ventilated area to dry.

Store the respirator, filters and cartridges in a clean, dry place, preferably a tightly closed paper or plastic bag.

Accidental splashing or transfer of pesticides to the mouth through wiping one's face on a sleeve, cuff or hand are likely ways for pesticides to enter the mouth. Other possibilities include food handled with contaminated hands; food exposed to spray, dust or spills of pesticides; contaminated drinking utensils and clearing nozzles by blowing through them.

Check the label for special instructions or warnings regarding exposure. Never eat, drink or smoke while spraying or dusting. Wash thoroughly with soap and water before eating or drinking.

If involved in operations that may result in splashing of pesticides, wear a full-face shield.

Signs and symptoms of organophosphorus poisoning may include fatigue, headache, dizziness, blurred vision, excessive sweating, nausea and vomiting, stomach cramps and diarrhea. Repeated exposure over a brief period may result in poisoning, all the more reason for minimizing exposure.

Signs and symptoms of moderate organophosphorus poisoning include inability to walk, weakness, chest discomfort, muscle twitches and constriction of the pupils of the eye.

Severe organophosphorus poisoning results in unconsciousness, severe pupil constriction, muscle twitches, secretions and breathing difficulty.

Signs and symptoms of carbamate poisoning are similar to those of organophosphorus poisoning. These include feelings of discomfort, excessive sweating, light-headedness, nausea, blurring of vision and excessive salivation and vomiting.

Signs and symptoms of chlorinated hydrocarbon pesticide poisoning vary but may include nausea, mental confusion or semiconsciousness, jerking of legs and arms, dizziness, drowsiness, weakness and loss of appetite.

Signs and symptoms of fumigant and solvent poisoning include poor coordination, slurred speech, confusion and sleepiness. Become familiar with the signs and symptoms of poisoning produced by the products you use and with the "statement of practical treatment."

A statement of practical treatment as first aid or other appropriate treatment is a part of most pesticide labels. Before using any pesticide, become familiar with the specific first aid information on the product label.

Pesticide poisoning signs may appear like brain hemorrhage, heat stroke, heat exhaustion, low blood sugar, gastroenteritis, asthma and pneumonia or other severe respiratory infections. If you become ill or experience any signs or symptoms, seek medical help immediately.

Back-siphoning, the reverse flow of liquids through pumps, can result in water contamination. In this manner, pesticides can be back-siphoned from the spray or mixing tank to the nurse tank, ponds, streams, wells and other water systems.

When delivering water to spray or mixing tanks, prevent back-siphoning with an air gap and a check valve. The distance between the hose and the top of the tank should be two times the diameter of the hose.

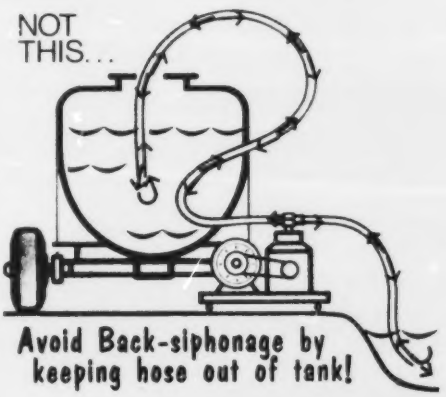
Always store pesticides intended for agricultural use in the original container with a legible label. Keep the storage unit away from food, feed or clothing; away from living quarters and in an area without temperature extremes or high moisture conditions.

Proper storage protects the health and well-being of people, pets and livestock; protects against environmental contamination and often extends shelf life of the chemical. Take special care in handling and storing pesticides to prevent fire and explosion. Fires involving pesticides present uncommon hazards, for example, highly toxic fumes, phytotoxic fumes, toxic runoff and toxic ash or other residues.

When storing pesticides, keep in a well-ventilated area, preferably a separate building. Do not store near food, feed or seed. Place warning signs at each point of entry and on all sides of the storage building. Keep the storage area locked when not in use; keep a log of pesticides and the amount of each in storage. Fireproof the area to the extent possible; check containers periodically for corrosion, leaks, breaks and tears and store "empty" containers in the storage area pending proper disposal.

Use the rinse and drain procedure to decontaminate "empty" pesticide containers and to minimize waste. This procedure involves rinsing "empty" containers three times with water or other diluent. Rinsings are added to the spray tank before filling the tank. For a pesticide costing $70 a gallon, the dollar loss from unremoved material amounts to $3.50 per 5-gallon can and up to $17.50 per 55-gallon drum. An empty pesticide container that has not been rinsed is far from empty, resulting in increased hazards to the environment, humans and animals, plus increased material cost and less efficient pest control.

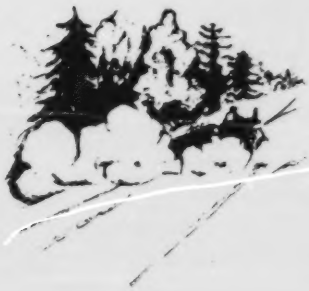
THIS PRODUCT CONTAINS 3.8 LBS OF PESTOFF PER GALLON
PESTOFF IS A REGISTERED TRADEMARK OF A-Z CORPORATION
KEEP OUT OF REACH OF CHILDREN
DANGER — POISON
STATEMENT OF PRACTICAL TREATMENT
SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS



When following label disposal directions such as the burning of paper or cardboard containers where permitted, stay out of smoke. Do not allow smoke to drift onto crops or areas occupied by humans or animals.

Suggested safety procedures are not intended as a substitute for specific information that appears on each pesticide product label. There are few safety recommendations that cover all situations . . . always read the label.

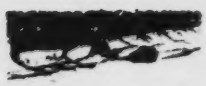
ENVIRONMENTAL CONSIDERATIONS

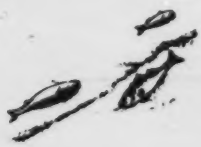


The environment is for all of us a place to live where many complex interactions and interdependencies exist. We can do a lot to insure that the use of pesticides does not create environmental problems. Improper use of pesticides (use other than as directed on the label) can (1) injure plants and animals, (2) leave illegal residues, (3) create greater pest problems and (4) damage wildlife and fish.

Pesticides become problems when they move off target. This may mean drifting out of the target area as a mist or dust; moving through runoff and erosion; leaching through the soil; being carried out as residues in crops, livestock or livestock products or evaporation and moving with air currents.

To minimize drift, use the largest droplet spray consistent with effective pest control and avoid spraying upwind from sensitive crops or pastures. Avoid spraying during high wind or air stagnations. Conditions that hold smoke close to the ground (a warm ceiling near ground level) will do the same to small drifting droplets of pesticides. The slowly settling droplets may concentrate on nearby crops.





Most fish and other aquatic organisms can survive only slight changes in their enviroment. Very small amounts of many pesticides can harm them or destroy the food they eat. They may die at once or change effects may result in their becoming more susceptible to prey or interfere with normal reproduction.

Pesticides may reach water directly, such as through application, drift, spills or incorrect disposal methods and indirectly through runoff, leaching and air cleansing rains.

Proper pesticide selection, handling, use and disposal will minimize pesticide problems in the environment.

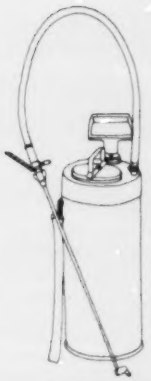
APPLICATION EQUIPMENT AND CALIBRATION

Mixing and calibration are other standards for private applicators. To prepare a proper pesticide concentration for a particular circumstance consider such factors as area to be covered, speed at which application equipment will be driven and the quantity

dispersed in a given period. When working with livestock or poultry, considerations may include age, size, number to be treated and formulation.

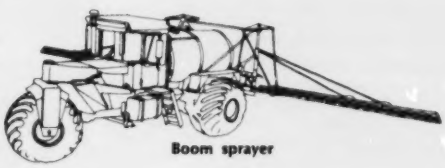
Application rates and mixing instructions also are a part of the product label. Often the label information regarding mixing will specify a certain procedure such as partially filling the spray tank before adding the pesticide product. Proper concentration in the spray tank and accurately calibrated equipment properly used will contribute to effective pest control.

A common type of pesticide application equipment is the sprayer. Sprayers may range from a hand sprayer for garden and ornamental application, to an air sprayer for orchard application, to a boom field sprayer or to a livestock sprayer.



Hand sprayer

A sprayer has several parts. The sprayer's delivery system may be a boom with several nozzles. The strainer system consists of a screen between the tank and pump, an in-line strainer between the pump and delivery system and a screen in each nozzle. Other parts are a shutoff valve, a pressure regulator and a pressure gauge. The sprayer also has a bypass line, suction line, pump and tank. An agitator line with a jet agitator prevents chemicals from settling out of the liquid mixture. Another agitator used in some commercially manufactured sprayers is a mechanical paddle agitator.

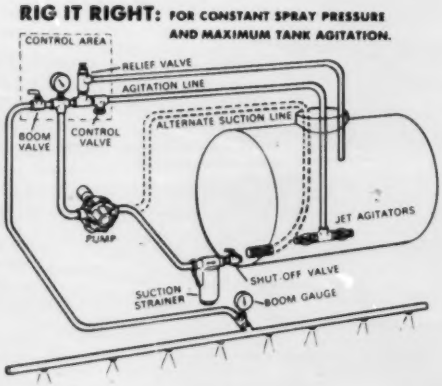


Boom sprayer

Pumps

The pump for agricultural sprayers should be capable of delivering the recommended discharge and pressure. No one pump is ideal for all sprayers; each type is designed for a specific application. Sprayers usually have roller, centrifugal or piston pumps.

RIG IT RIGHT: FOR CONSTANT SPRAY PRESSURE AND MAXIMUM TANK AGITATION.

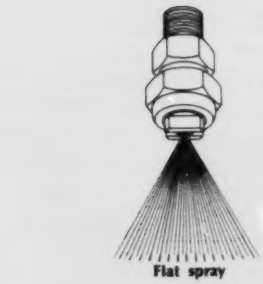


The roller pump develops pressures up to 300 pounds per square inch with pumping capacities up to 30 gallons per minute. Nylon rollers are recommended for nonabrasive materials with rubber rollers recommended for abrasive materials such as wettable powders.

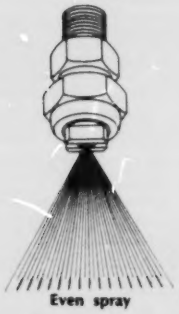
Centrifugal pumps have a high volume capacity of up to 125 gallons per minute but their low pressure limits them to applications of 50 pounds per square inch or less. Centrifugal pumps effectively handle abrasive materials such as wettable powders.

Piston pumps are high pressure units operating up to 600 pounds per square inch at volumes up to 25 gallons per minute. They are very resistant to wear.

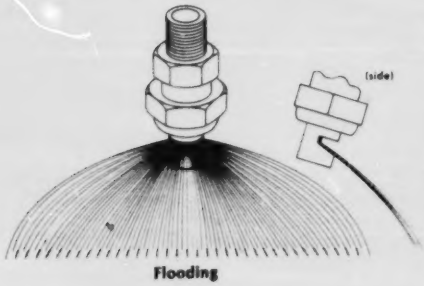
Pump size is important. The pump should have capacity to supply all nozzles on the spray boom plus capacity for agitation if the sprayer tank is not outfitted with a mechanical agitator. This agitation is extremely important when using wettable powders. Agitating wettable powders requires 2 to 3 gallons per minute per 50 gallons of mixture in the tank.



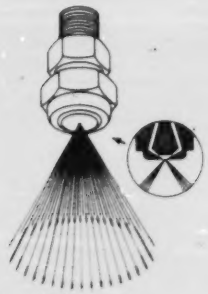
Flat spray



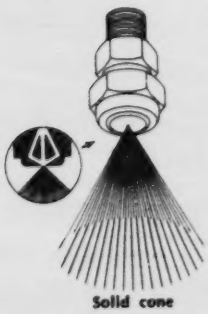
Even spray



Flooding



Hollow cone



Solid cone

Pressure gauge

Select the pressure gauge to read in the range of pressures to be used. Generally, select a gauge that has a range twice the maximum reading expected. For example, for pressures up to 50 pounds per square inch, select a 100-pound-per-square-inch gauge.

Nozzles

Nozzles control the amount of material applied, droplet size and pattern. Manufacturer catalogs contain information for choosing a nozzle to give the desired spray pattern, angle, droplet size and discharge rate. Remember that output changes as the nozzle wears and frequent checking is required for continued accurate application.

A typical nozzle includes a nozzle body, strainer, tip and cap. The nozzle strainer is selected as recommended by the manufacturer to fit the nozzle tip selected. The smallest strainer recommended for spraying wettable powders is 50 mesh.

Nozzle tips are available in various materials including brass, nylon or plastic, stainless steel and hardened stainless steel. Brass tips wear extremely fast when spraying wettable powders.

Many spray patterns are available. The flat spray tip is designed for normal operating pressures of 20 to 40 pounds per square inch. The flat spray tip produces a fan pattern with less material applied along the edges to allow overlap along a boom. With flat spray tips, the boom height is adjusted so patterns overlap on each side. The overlap is about 40 percent of the spacing between nozzles. For example, if boom nozzles are 20 inches apart, the patterns should overlap 8 inches.

Even spray tips are designed for normal operating pressures of 20 to 40 pounds per square inch. The even spray tip produces a uniform volume of spray across the entire fan width. This tip is used for band spraying.

Solid and hollow cone tips are designed for pressures of 40 to 400 pounds per square inch. This high pressure breaks the spray into small droplets to provide more complete plant coverage. Cone nozzles produce a circular pattern. The hollow cone tip sprays material only along the outside of the pattern while the solid cone sprays material throughout the pattern. The type of cone selected depends on volume of spray to be applied. Cone nozzles are used for insecticides and fungicides where complete coverage and foliage penetration are required.

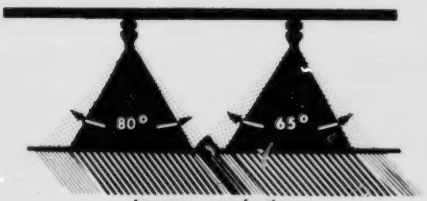
Other nozzle tips are available for specific applications. For example, a flooding nozzle will spray a wide surface while operating close to the sprayed surface. Placed at 40-inch spacing and operated at 10 to 20 pounds per square inch, the flooding nozzle will apply post-emergence chemicals to the row middles of growing crops.

Use and maintenance

Various problems may be encountered with boom sprayers. On a boom, be sure that all tips produce the same pattern angle. Different pattern angles can cause skips or too much overlap.

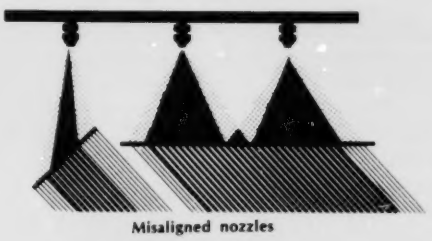
- A mixture of nozzle types gives incorrect coverage.
- Worn or plugged tips may cause skips.
- If tips are not aligned parallel with the boom, skips will occur.
- If the sprayer boom is not level, coverage will be irregular.
- If the pressure is too high, droplets will become too small and drift, giving uneven application.
- If the pressure is too low, patterns will not properly overlap, giving inadequate coverage.

To clean nozzle tips, use a soft brush such as a toothbrush. Tips may be damaged if cleaned with a knife or wire.



Improper nozzle tips

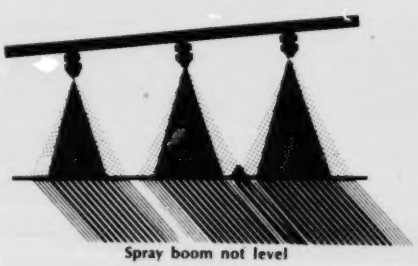
Worn or plugged nozzles


Misaligned nozzles

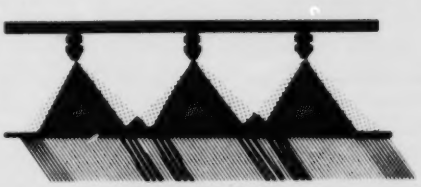
Drift

Weather conditions directly affect the direction, amount and distance of drift. Avoid application when the wind is blowing toward susceptible crops. High winds can move pesticides from the treated area causing poor coverage and possible damage in adjoining fields.

During early morning and late evening hours, the difference in the air temperature at ground level and at some distance above ground is considerably less than during the middle of the day. As the ground warms up, the air temperature near the ground increases above that of the air above the ground. This warmer air rises and may set up convection and thermal air currents which lift small particles. These suspended particles may be carried some distance before they settle out. Avoid applications when this condition exists.

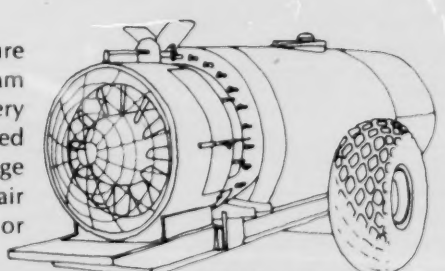

Spray boom not level

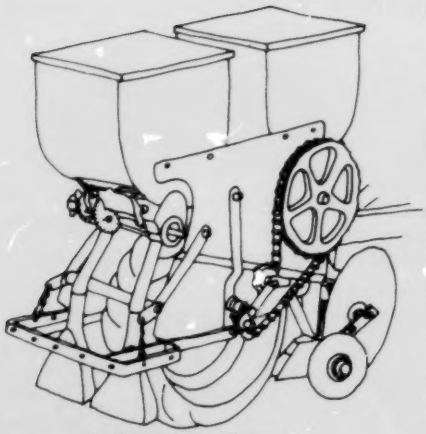
Calm conditions with a high inversion of ground air 2° to 5° cooler than the air above may result in small spray droplets or dust particles remaining suspended as a dense cloud in a layer of undisturbed air. The entire cloud may be moved out of the area before coming to rest, resulting in relatively high drift deposits. Avoid application under this condition. Sufficient turbulence is needed in the atmosphere to disperse clouds of small spray drops when spray is applied.


Spray boom too low

Air sprayers

The difference between air or mist sprayers and field or pasture sprayers is that a high volume fan is used to produce an air stream to carry spray droplets to the target area. Good coverage is very difficult in winds over 5 miles per hour. Air sprayers are equipped with cone nozzles to give small droplet sizes for complete coverage and are used primarily for disease and insect control. Most air sprayers require high pressure and are equipped with piston or multistage centrifugal pumps.


Air-blast sprayer



Band granular applicator

Granular applications

Granular applicators are available for band or broadcast coverage and may be used for applying granular materials into the soil.

Injector equipment

Injector equipment applies liquid pesticide into the soil with the amount of pesticide applied controlled by a flow meter. This equipment is quite variable in appearance and use.

Calibration

Too often one essential operation gets overlooked in pesticide application. Calibration or equipment adjustment is essential to obtain desired rates. Calibrate application equipment before every use to insure good pest control and to avoid the hazard and expense of over application.

The application rate per acre for pesticides is usually given as a broadcast rate. Rate per acre on a broadcast basis means the amount of pesticide per acre treated. With broadcast application, the entire area is covered and the rate per acre on a broadcast basis will be the same as rate per acre of land. With band application, the rate per acre on a broadcast basis will not be the same as rate per acre of land. Rather, it is the rate per acre of land actually treated. For example, a herbicide rate is given as 1 pound per acre on a broadcast basis. If the herbicide is broadcast, 1 pound of herbicide would be applied to 1 acre of cropland. If the herbicide is applied in 12-inch bands on 36-inch rows, 1 pound of herbicide would cover 3 acres of cropland.

Before calibrating a sprayer the discharge should be checked from each nozzle. Only **water** should be used in the tank when checking nozzle discharge or calibrating a sprayer. Even though water is used, all pesticide safety precautions should be observed because residual pesticide may be present in the sprayer system. With the sprayer stationary and operating at the pressure to be used in the field, catch and record the spray discharge in ounces from each nozzle. Calculate the average nozzle discharge per minute by adding the discharge from each nozzle and dividing by the number of nozzles. Replace the tip in any nozzle that has a flow rate of 10 percent more or less than the average of the nozzles in the system. If any nozzle tips are replaced, catch the discharge for 1 minute, calculate a new average and check to see if the new tips fit within the discharge limits.

There are many methods of sprayer calibration that may be used. The important consideration is that some method of calibration be used so that equipment may be adjusted to apply the desired amount of a pesticide to a given area.

Some operators prefer to calibrate by spraying an **exact** known area such as an acre, a half acre or a quarter acre. This is a good method and requires a minimum of calculation to determine gallons of mixture applied per acre.

Known area method

One sprayer calibration method is to spray a known area.

1. Measure a distance in the field to be sprayed. A good distance is 660 feet.
2. Fill the sprayer tank with water to a known level.
3. Select a tractor throttle or miles per hour setting in the gear to be used.
4. Select a pressure setting within the recommended range for the application.
5. Spray the measured course.
6. Refill the tank to the known level, measuring amount of water required.
7. Measure the swath width sprayed in feet.
   When broadcast spraying, the swath width in feet will be the number of nozzles on the boom multiplied by the nozzle spacing in inches and divided by 12. When band spraying, the swath width in feet will be the number of bands multiplied by the bandwidth in inches and divided by 12.
8. The application rate in gallons per acre may now be calculated by this formula.

$$\text{GPA} = \frac{43{,}560 \times \text{gallons used}}{\text{length (ft.)} \times \text{swath width (ft.)}}$$

   a. GPA means gallons per acre or gallons of mixture applied per acre.
   b. 43,560 is the number of square feet in 1 acre.
   c. Gallons used is the number of gallons used to spray the measured course and measured to the nearest 1/10 gallon.
   d. Length is the length of the measured course in feet.
   e. Swath width is the width sprayed over the measured course in feet.

In this example of broadcast spraying, we have sprayed 6 gallons and 2 quarts or 6.5 gallons. The measured course is 660 feet long. We have a boom with 13 nozzles spaced on 20-inch centers for a swath width of 21.7 feet.

$$\text{Swath width (ft.)} = \frac{\text{no. nozzle} \times \text{nozzle spacing (in.)}}{12}$$

$$\text{Swath width (ft.)} = \frac{13 \times 20}{12}$$

$$\text{Swath width} = 21.7 \text{ feet}$$

Substituting in the formula, we get an application rate of 19.8 gallons per acre.

$$\text{GPA} = \frac{43{,}560 \times \text{gallons used}}{\text{length (ft.)} \times \text{swath width (ft.)}}$$

$$GPA = \frac{43{,}560 \times 6.5}{660 \times 21.7}$$

$$GPA = 19.8$$

In this example of band spraying, we have sprayed 2 gallons and 3 quarts which is 2.75 gallons rounded to 2.8 gallons. The measured course is 660 feet long. We are spraying six rows with 12-inch bands for a swath width of 6 feet.

$$\text{Swath width (ft.)} = \frac{\text{no. bands} \times \text{bandwidth (in.)}}{12}$$

$$\text{Swath width (ft.)} = \frac{6 \times 12}{12}$$

$$\text{Swath width} = 6 \text{ feet}$$

Substituting in the formula, we get an application rate of 30.8 gallons per acre.

$$GPA = \frac{43{,}560 \times \text{gallons used}}{\text{length (ft.)} \times \text{swath width (ft.)}}$$

$$GPA = \frac{43{,}560 \times 2.8}{660 \times 6}$$

$$GPA = 30.8$$

Stationary method

Another sprayer calibration method is a stationary method, calculated by determining rate by nozzle output per minute. The first step in this method is to determine sprayer speed in miles per hour. To do this, measure a distance of 300 feet in the field to be sprayed. Time, in seconds, how long it takes to travel the distance at the desired spraying speed. Then divide 204 by the number of seconds to travel 300 feet.

$$MPH = \frac{204}{\text{seconds to travel 300 feet}}$$

With the tank filled with water, the sprayer stationary and operating at the pressure to be used in the field, catch and record the sprayer discharge in ounces for 1 minute from each nozzle. Calculate the average nozzle discharge per minute by adding the discharge from each nozzle and dividing by the number of nozzles. The application rate in gallons per acre for broadcast spraying may be calculated by this formula.

$$GPA = \frac{\text{ounces per minute}}{\text{nozzle spacing (in.)} \times MPH} \times 46.4$$

- GPA means gallons per acre or gallons of mixture applied per acre.
- Ounces per minute is the average nozzle discharge in ounces per minute.

- Nozzle spacing is the distance between nozzles measured in inches.
- MPH is the sprayer speed in miles per hour.
- 46.4 is a constant used in the formula.

In this example of calculating sprayer speed, it takes 51 seconds to travel 300 feet. Dividing 204 by 51 gives a speed of 4 miles per hour.

$$\text{MPH} = \frac{204}{\text{seconds to travel 300 feet}}$$

$$\text{MPH} = \frac{204}{51}$$

$$\text{MPH} = 4$$

In this example of broadcast spraying, we have an average nozzle discharge of 35 ounces per minute, nozzles are spaced on 20-inch centers and the sprayer speed is 4 miles per hour. Substituting in the formula, we get an application rate of 20.3 gallons per acre.

$$\text{GPA} = \frac{\text{ounces per minute}}{\text{nozzle spacing (in.)} \times \text{MPH}} \times 46.4$$

$$\text{GPA} = \frac{35}{20 \times 4} \times 46.4$$

$$\text{GPA} = 20.3$$

The application rate in gallons per acre for band spraying may be calculated by this formula.

$$\text{GPA} = \frac{\text{ounces per minute}}{\text{bandwidth (in.)} \times \text{MPH}} \times 46.4$$

All parts of the formula are the same as for broadcast spraying except bandwidth in inches is substituted for nozzle spacing.

In this example of band spraying, we have an average nozzle discharge of 31 ounces per minute, bandwidth is 12 inches and the sprayer speed is 4 miles per hour. Substituting in the formula, we get an application rate of 30 gallons per acre.

$$\text{GPA} = \frac{\text{ounces per minute}}{\text{bandwidth (in.)} \times \text{MPH}} \times 46.4$$

$$\text{GPA} = \frac{31}{12 \times 4} \times 46.4$$

$$\text{GPA} = 30$$

There are many calibration methods that may be used. The important point to remember is to calibrate equipment before every use.

To increase sprayer application rate slightly, decrease groundspeed or increase pressure or both. To decrease application rate slightly, decrease pressure or increase groundspeed or both. Make big changes in application rate by changing the size of nozzle tips.

Recalibrate sprayers often to determine changes in application rate because of nozzle wear. Manufacturers provide tables showing relationship between speed, pressure and gallons per acre that help simplify nozzle selection and calibration.

The principles used to calibrate sprayers also may be used to calibrate granular applicators. Output over a known area may be caught and weighed, or the amount applied may be replaced, weighing the amount it takes. With the amount applied over the known area, the amount used per acre may be calculated.

Pesticide mixing

Few pesticides are available as pure material and recommendations are often written in terms of active ingredient, not the product's total volume. Further confusion is added if recommendations are in terms of pounds per acre with the product packaged in gallons or listed by percentage.

This formula may be used to calculate the pounds of purchased material to be used per acre.

$$\frac{\text{Pounds active ingredient per acre}}{\text{Percent active ingredient}} = \text{Pounds of purchased material to use per acre}$$

Divide the pounds of active ingredient you want to apply per acre by the percent active ingredient in the formulation.

In this example, we have a 50 percent wettable powder and want to apply 1 pound of active ingredient per acre. Fifty percent wettable powder means that 50 percent of the formulation is active ingredient. Substituting in the formula, we get 2 pounds of 50 percent wettable powder used per acre to get 1 pound active ingredient per acre.

$$\frac{\text{Pounds active ingredient per acre}}{\text{Percent active ingredient}} = \text{Pounds of purchased material to use per acre}$$

$$\frac{1}{.50} = 2 \text{ pounds per acre}$$

To determine the gallons of purchased material to use per acre, use this formula. Divide the pounds of active ingredient you want to apply per acre by the pounds of active ingredient per gallon.

$$\frac{\text{Pounds active ingredient per acre}}{\text{Pounds active ingredient per gallon}} = \text{Gallons of purchased material to use per acre}$$

In this example, we have a pesticide that contains 4 pounds active ingredient per gallon, and we want to apply 2 pounds of active ingredients per acre. Substituting in the formula, we get ½ gallon of purchased material used per acre to get 2 pounds active ingredient per acre.

$$\frac{\text{Pounds active ingredient per acre}}{\text{Pounds active ingredient per gallon}} = \text{Gallons of purchased material to use per acre}$$

After determining application rate in gallons per acre and the number of pounds or gallons of purchased material to apply per acre when using a sprayer for pesticide application, the pounds or gallons per tank of mixture may be calculated. First, determine the number of acres a tank will treat. This is done by dividing the number of gallons in the tank by the gallon per acre application rate.

$$\text{Acres tank will treat} = \frac{\text{Gallons in tank}}{\text{Gallons per acre application rate}}$$

The amount of purchased material to add to the tank is found by multiplying the acres the tank will treat by the amount of purchased material to apply per acre.

$$\text{Purchased material to put in tank} = \text{Acres tank will treat} \times \text{Purchased material per acre}$$

In this example, we want to apply ½ gallon of purchased pesticide per acre, the application rate is 25 gallons per acre and the tank will hold 200 gallons. Dividing 200 by 25, the tank will treat 8 acres.

$$\text{Acres tank will treat} = \frac{\text{Gallons in tank}}{\text{Gallons per acre application rate}}$$

$$\text{Acres tank will treat} = \frac{200}{25}$$

$$\text{Acres tank will treat} = 8$$

Multiplying 8 by ½ we get 4 gallons of purchased material to put in the tank.

$$\text{Purchased material to put in tank} = \text{Acres tank will treat} \times \text{Purchased material per acre}$$

$$\text{Purchased material to put in tank} = 8 \times \tfrac{1}{2} \text{ gallon}$$

$$\text{Purchased material to put in tank} = 4 \text{ gallons}$$

The tank would be partially filled, 4 gallons of pesticide added and the tank then filled to 200 gallons.

In this example, we want to apply 2 pounds of purchased wettable powder per acre, the application rate is 25 gallons per acre and the tank will hold 200 gallons. Dividing 200 by 25, the tank will treat 8 acres.

$$\text{Acres tank will treat} = \frac{\text{Gallons in tank}}{\text{Gallons per acre application rate}}$$

$$\text{Acres tank will treat} = \frac{200}{25}$$

$$\text{Acres tank will treat} = 8$$

Multiplying 8 $\times$ 2 we get 16 pounds of wettable powder to put in the tank.

$$\text{Purchased material to put in tank} = \text{Acres tank will treat} \times \text{Purchased material per acre}$$

$$\text{Purchased material to put in tank} = 8 \times 2 \text{ pounds}$$

$$\text{Purchased material to put in tank} = 16 \text{ pounds}$$

Fill the tank about half way and start the sprayer to begin tank agitation. Mix the wettable powder in a bucket with a little water, stir into a slurry and then add to the tank. Next, finish filling the tank.

As you work, protect yourself and the environment from pesticide hazards and if questions arise, get help from your county Extension agent.

PESTS AND PEST DAMAGE

Pests normally associated with crops and livestock include insects, parasites, plant disease, weeds, brush and animals such as rodents, predators and birds. Knowledge of the pest and its damage is the essential first step in managing a pest problem. All management decisions that follow can be made correctly only if the problem has been diagnosed properly. Initially identification of crop and livestock pests is based primarily on observations of

either the pest, its damage or signs of damage. Later identification is made through the process of elimination with a knowledge of hosts, the pests, damage, time of year, etc.

Plants may be injured by a variety of pests, including insects, mites, fungi and animals. Weeds and brush compete with plants for available moisture, plant nutrients and space. Livestock and poultry are subject to attack by internal and external parasites. However, plants also are susceptible to injury by drought, hail, nutritional deficiencies and chemicals, such as certain air pollutants. Similarly, livestock and poultry are subject to disease and nutritional disorders. Two or more causes may produce signs and symptoms so similar that the exact cause may be difficult to determine. In fact, plant disease-causing organisms and nematodes are identified only by experts with the aid of a microscope.

Thus, we see the need for identifying the pest and pest damage which is included in the federal standard for private applicators. You are familiar with the pests and their damage to the crops and livestock you produce. It may be beneficial, however, to review the common, as well as some of the unique, considerations involved in pest identification, damage and control.

INSECT PESTS

Insects, found almost everywhere on the face of the earth, damage virtually anything of value to man.

Insect pests feed on leaves, stems, stalks, branches, seeds, fruits and nuts. Or, they suck sap from leaves, stems, roots, fruits and flowers. Some also carry disease agents of man, animals and plants.

Pest recognition

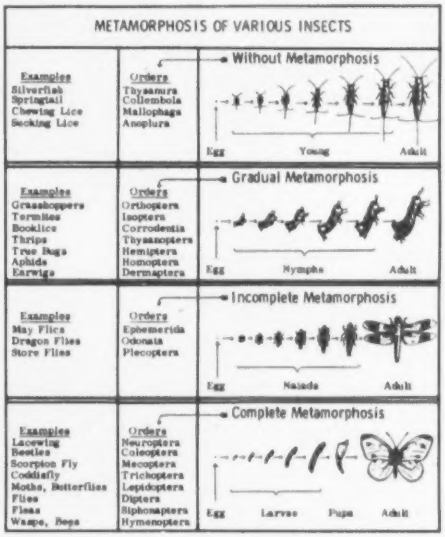
To solve a pest problem, you must first identify it. Identification is easier if you know something about insects.

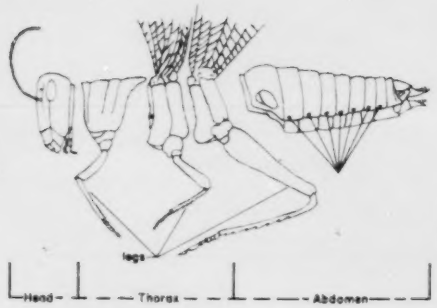
Most insects change form and size as they grow to adults. Some, such as silverfish, springtails and sucking and chewing lice, only increase in size from immature to adult stages. Others, such as the grasshopper illustrated here, increase in size primarily, but the adults are winged. This kind of growth is typical of grasshoppers, aphids, termites, booklice, true bugs, etc.

With insects having complete metamorphosis, the immature stages and adults differ considerably in appearance as well as habitat and food preferences in many cases. This growth is typical of beetles, moths, butterflies, flies, fleas, wasps, bees, etc.

All adult insects have two things in common:

- Three pairs of jointed legs





- Three body regions
  - — Head
  - — Thorax
  - — Abdomen

You can tell one kind of adult insect from another by comparing their wings, mouthparts, size, shape and markings. Some do not have wings, others have two wings and many have four wings.

Insects that chew have tooth-like mouthparts used for biting, tearing or skeletonizing host tissues. Those that suck internal plant fluids or blood have needle-like, piercing mouthparts or beaks.

Close relatives of the insects are the mites, ticks and spiders. One important difference is they have eight legs, not six. They are wingless and have only two body regions:

- Combined head and thorax
- Abdomen

You can identify many insect pests encountered in your farm or ranch operation. If, however, you need assistance on identification problems, contact a local expert.

Silverfish

Sucking louse

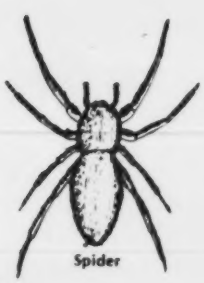
Fly (two wings)

Dragonfly (four wings)

Chewing

Sucking

Types of mouthparts


Spider

Tick

Insect pests

More than 250,000 kinds or species of insects are known to occur in the U.S. The many insects (including spiders, ticks and mites) are commonly grouped in three categories according to their impact on man.

The largest category, comprising more than 90 percent of the insects, includes those commonly recognized as having essentially no direct detrimental or beneficial influence on man. They provide food for fish, birds, amphibians, skunks, bats, armadillos and other animals in the intricate food chain of nature. Insects are also nature's scavengers.

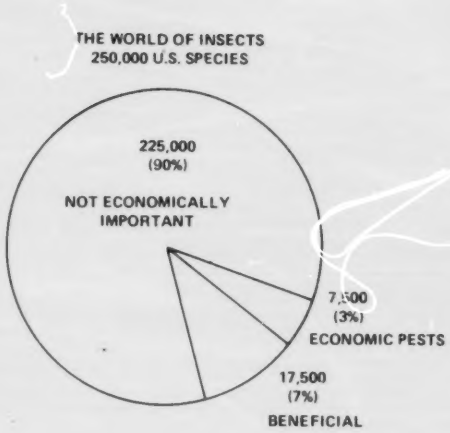
The second largest insect group comprises those classified as beneficials. Many spiders, mites and insects are either parasites or predators of destructive species. These beneficial insects provide important natural control of economically important pests. In their absence, man would be unable to cope with his insect problems.

Included in this group are lady beetles, tiger beetles, parasitic wasps, lacewing fly larvae, most spiders and many others. Also in this category are the insect pollinators — bees, wasps, ants, butterflies and certain beetles, flies and thrips. Their economic value to man exceeds several billion dollars annually.

Economically important or destructive species fall in the third, and smallest, category. This group includes fewer than 3 percent of the known U.S. species. Of this number only 150 to 200 regularly cause economic damage. An additional 400 to 500

species are sporadic pests. Another 6,000 are minor pests or classed as nuisance pests but cause no real economic loss or health damage.

It is fortunate that the number of economically destructive pests are few, otherwise man would be seriously challenged to keep them controlled. This also indicates the importance of clearly and accurately identifying a pest problem. Effective, economical control depends on your accuracy.



Pest control

Natural control of pest species accounts for more than 99 percent of the reduction in potential insect damage. These factors include:

- Climate — temperature, rainfall, radiation or sunlight
- Physical factors — mountain ranges, seas and other water barriers and dominant plant and animal competitors
- Predators and parasites — insects, mites, spiders, nematodes, mammals, reptiles and fish
- Insect diseases — bacteria, viruses and fungi

When natural control factors fail to hold pest populations below economic damage levels, man must intervene and use artificial control techniques. Knowing **when** to use a specific control measure, or combination of control methods, is the greatest challenge facing the agricultural producer.

Included in man's arsenal of artificial controls are:

- Mechanical and physical methods
- Cultural methods
- Biological control
- Legal control (quarantines, etc.)
- Genetic control (insect resistant varieties, etc.)
- Chemical control

Pest categories

Most insect pests fall into one of three basic categories:

- Key pests
- Occasional pests
- Secondary pests

Key pests are the insects or mites which cause constant economic losses almost annually. **Occasional pests** infrequently cause economic losses, generally under a specific set of weather or cropping conditions.

Secondary pests are occasional pests or non-pests which cause economic losses due to a manmade disruption, such as the destruction of natural enemies, including parasites or predators, through the misuse of an insecticide which allows the pest population to develop unrestricted in the absence of its natural enemies.

Economic threshold--when to treat

An insect pest must be present in sufficient numbers and cause a certain level of damage to justify the dollar investment for control. The mere presence of an insect pest does not necessarily result in a loss in quality or quantity of an agricultural commodity or an animal product. The term "economic threshold" is frequently used to denote a point in the development of a pest population or the damage level caused by a pest which warrants application of a control measure, such as an insecticide application.

This means the largest number of insects and/or damage that can be tolerated before economic injury or loss occurs. Economic thresholds have been determined for many insect pests on Texas' crops and livestock. A few examples are discussed in the following paragraphs.

For boll weevils on cotton 15 to 25 percent of the one-third grown squares must have boll weevil oviposition punctures before economic damage occurs. This damage level or economic threshold increases as the "boll set" increases.

Table 1. Economic threshold for boll weevil

Crop	Pest	Economic threshold or "when to treat"
Cotton	Boll weevil	When 15 to 25 percent of the one-third grown squares have weevil egg-laying punctures and the cotton has not set a full "boll load"

The sorghum midge is a key pest of grain sorghum. Several factors, however, must be considered in determining whether insecticides are needed to prevent economic damage. When 25 to 30 percent of the heads are in bloom, economic damage occurs when adult midge numbers average more than one per head.

Table 2. Economic threshold for sorghum midge

Crops	Pest	Economic threshold or "when to treat"
Grain sorghum	Sorghum midge	When 25 to 30 percent of the heads are in bloom and the number of adult midges average more than one per head

The greenbug is also a key pest of grain sorghum. The economic threshold for this aphid varies with plant size and maturity.

Young plants from the seedling stage to approximately 6 inches in height can suffer economic losses where visible damage plus the presence of active greenbug colonies are found. On larger plants, approximately 6 inches in height to preboot, the economic

Table 3. Economic threshold for greenbug

Crop	Pest	Plant age or maturity	Economic threshold or "when to treat"
Grain sorghum	Greenbug	Seedling to 6 inches tall	Visable damage with greenbug colonies present
		6 inches tall to preboot	Before any entire leaf is killed with greenbug colonies present
		Boot to hard-dough	When greenbug damage is sufficient to cause the death of more than two normal-sized leaves and greenbugs are present

threshold occurs just before the loss of an entire leaf plus the presence of greenbug colonies. From boot to the hard-dough stage, plants can tolerate the loss of two, normal-sized leaves with active developing greenbug colonies before chemical treatment is required.

It is apparent that not only the insect population level but the age of the plant, stage of fruiting, specific weather factors and activity of parasites and predators are commonly important considerations in determining the economic threshold for a particular pest and crop complex.

In agricultural systems, when the economic threshold is reached, immediate control measures must be taken to avoid or reduce economic damage. Usually this requires applying an effective, labeled insecticide. For this reason the economic threshold is equated with "when to treat" in most guidelines or publications relating to pest control.

The most important factor in determining "when to treat," based on economic thresholds, is crop or livestock inspection. Crops or animals must be checked on a regular basis, usually weekly or more often during the pest season, to accurately determine the pest population level and existing damage before economic thresholds can be used properly. Applying insecticides based upon economic thresholds results in dollar savings to the farmer and prevents needless insecticide applications.

Summary

In the previous discussion of insect pests, there are three points to reemphasize.

- Accurate pest identification is the first step in any sound pest control program. This is important because fewer than 3 percent of the insect species in the United States are pests.

- Use established economic thresholds or "when to treat" guidelines to determine the need to apply an artificial control. The mere presence of destructive or pest species does not mean it will be profitable to employ one of the artificial control methods.
- Determine which control method will be most effective and return the greatest net profit.

The ability of the private applicator — the Texas farmer or rancher — to recognize his pest problem, accurately determine the damage potential and select the appropriate artificial control method, where one is required, will significantly influence the economic position of his farm or ranch enterprise and accurately reflect on his competence in using restricted-use pesticides.

PLANT DISEASE CONTROL

Angular leafspot of cotton

Typical leafspots produced by fungi

Man has had great difficulty dealing with the unseen world that he referred to as blast, blight and mildew. Robigus, "The God of Rusts," was invented to appease the spirits and prevent rust from attacking grain crops. It was probably by accident that sulfur came to be used as an effective fungicide. It represents the oldest fungicide used today.

While research has revealed the cause of disease, much confusion still exists concerning actual occurrence in people's minds. Weather is often blamed for disease, whereas it actually creates conditions that permit occurrence.

Microscopic organisms that cause disease are fungi, bacteria, nematodes and viruses. While viruses are not organisms in the truest sense, they are capable of multiplication, and these large organic particles are infectious to plants. Microscopic organisms or entities that cause disease have definite shapes. They have tremendous reproductive capacities, and this permits rapid infection when conditions are favorable.

Three factors are required for infection to occur, including a susceptible host, presence of the organism and a favorable environment. Removing any one of these factors prevents infections. Microscopes are required to see disease-causing organisms, so another system of disease recognition must be employed. Under field conditions, we rely upon symptoms to identify disease damage. This may be in the form of leafspot, blights, wilts or sudden death of plants. From this point, we will deal with common names of diseases and their appearance in the field.

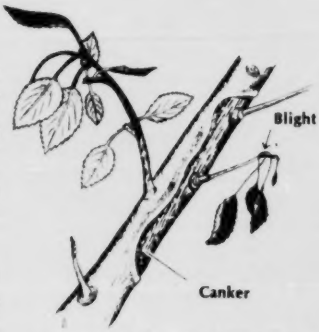
Control recommendations are based on practices designed to prevent specific disease conditions. For example, leafspot occurs in all peanut-producing areas annually. It is caused by a fungus that overwinters in crop residue in soil. It has a distinct appearance in the form of a circular brown-to-black spot on the leaf surface. These spots are distinctive. In fact, they are so distinctive that they

can be used to diagnose the disease without observing spores of the fungus that cause it. This is a great help and permits field diagnosis on the basis of symptoms.

Germinating spores

Other types of spots are caused by bacteria, such as bacterial blight of cotton. An angular spot is formed because veins of the leaf restrict spread of the infection. Bolls as well as the leaves are infected. Spots appear differently on various types of plants. With southern corn leaf blight, spots usually are numerous and somewhat elongate in shape. The fungus that causes this disease is carried over in crop residue. Spores are blown by air from the point of origin and, because of the large number produced, some will land on susceptible plants.

Blight is another term used to describe disease symptoms. This describes the rapid discoloration and death of tissue over certain portions of the plant. It usually results in killing leaves, flowers and stems. Such is the case with fire blight, a bacterial disease of pears and apples.



Typical fire blight symptoms

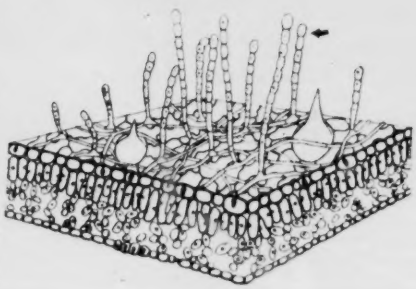
Rots of fruits and vegetables may be caused by fungi or bacteria. Brown rot of peach is caused by a fungus capable of killing blossoms as well as rotting the fruit. Infected fruit is not edible, and fungicides must be used to prevent initial infection. Commercial fruit producers must constantly battle this problem with regularly applied protectant fungicides.

Fungicides prevent spore germination and stop the infection process. If a protective film can be kept on the surface, damage can be prevented. Furthermore, fungicides must be applied so that even distribution on the foliar surface will be insured.

Rusts are caused by fungi that have a limited host range. A particular rust fungus usually affects only a few closely related plants. For example, leaf rust of oats does not infect wheat. Spores, the small reproductive bodies, are windborne for many miles.

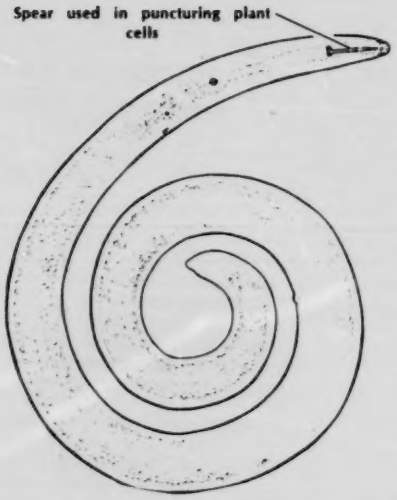
Smuts occur on many crops, but again, a particular type of smut fungus only affects closely related plants. Head smut, for example, usually affects only sorghum even though corn has been affected occasionally. The grain sorghum head is replaced completely by a mass of black spores. These spores fall to the soil and permit overwintering of the fungus.

Mildews are caused by fungi that infect cells on the leaf surface. The powdery mildew fungus infects ornamentals and many vegetables. A loss of plant vigor is noted on infected ornamentals, and plant death usually results on vegetables.



Typical growth of powdery mildew on a leaf showing formation of spores (see arrow)

Downy mildew is a completely different disease from powdery mildew. It affects many types of plants, but the most common are squash, cantaloupe and cucumbers. Yet another type of downy mildew attacks sorghum and corn. Primary infection takes place on the root system below the soil. Infected plants assume a striped



General shape of a nematode

appearance and will be sterile. Since the plant will not produce grain, it is actually a weed.

Mosaics are caused by viruses. The maize dwarf mosaic on grain sorghum has a mottling effect in the upper leaves. This virus is transmitted by aphids from infected Johnsongrass to grain sorghum and corn. Once a plant is infected, it will remain so for life. Johnsongrass shows the same symptoms as those on corn or grain sorghum. If Johnsongrass is controlled in and around the field, early infection will be reduced.

Nematodes are microscopic roundworms that live in the soil. Certain types are parasitic and feed on living plants. These cause plant stunting along with uneven growth and chlorotic foliage. The most common plant parasitic nematode is the root-knot-nematode which causes knots or galls to form on the roots. This places a severe restriction on the plant's ability to absorb water and nutrients. Plants may even die when placed under drought stress.

Plant diseases and nematodes can be controlled by efficiently using chemical and cultural control recommendations. In some cases, they can be controlled by using resistant varieties and in other cases, one must rely on chemicals. When chemicals are needed, one should use them at suggested intervals to get the highest level of control possible.

When planning disease control programs keep the following concepts in mind:

- Disease-causing organisms are microscopic in size.
- Recognizable symptoms are produced on the plant.
- All plant disease-causing organisms can be controlled to a degree where damage will be reduced.

Seedling disease of cotton

Disease damage is prevented more easily than controlled. Effective prevention methods include using cultural practices such as crop rotation with unrelated crops, planting disease-resistant varieties and utilizing specific land preparation practices. Chemical control often is needed as a supplement when cultural practices are ineffective alone.

Disease control chemicals are classified variously as fungicides, bactericides and nematicides. These names give us a clue as to the type of diseases they will control. Many chemical products exist under each classification. Extension recommendations will serve as a guide in suggesting a variety of products that will control a specific disease condition. Product labels will then tell you how the product can be used for effective control.

If you have chosen chemical control as a course of action, don't forget to continue the use of suggested cultural practices. This will improve the results you obtain from chemical control and enhance

the value of the product you produce. All plant disease damage can be reduced and in some cases eliminated.

Weeds and economic importance

Weeds and brush are nuisances, causing extra mowings on roadsides and obstructing water flow in drainage facilities. Weeds may harbor insects and diseases which attack adjoining crops.

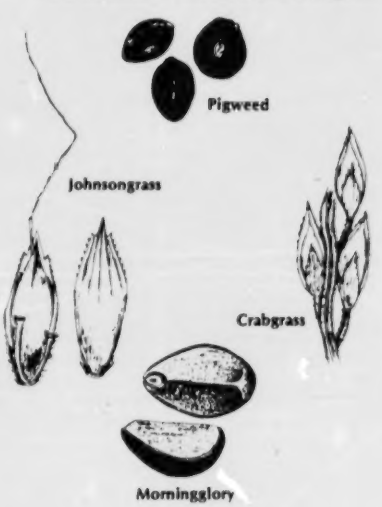
Weed seed may adversely affect grain quality. Dayflower seed in rice is one example. Poison ivy causes skin irritation and stinging nettle causes skin rash. These weeds are a nuisance in park and recreational areas and in some lawns.

The cool season weeds — annual bluegrass, clovers and lawn burweed — reduce turf quality in home lawns and on golf courses. Weeds reduce the yield of valuable crops by competing for moisture, nutrients and light. For example, pigweed, Texas panicum and tall morningglory compete with corn and grain sorghum.

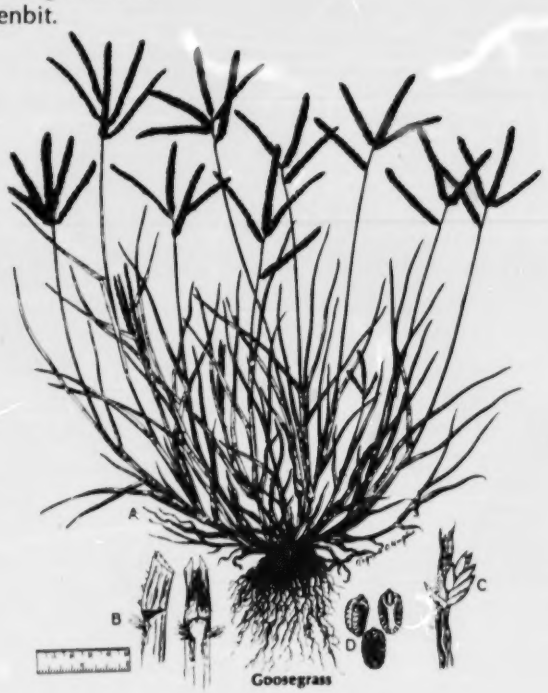
Weed identification

Weeds can be identified from the growing plants and their seeds. The season and duration of growth determine the time and frequency of chemical treatment for control.

Annual weeds complete their life cycle within 1 year. They may be winter annuals germinating in the fall, overwintering and completing their life cycle the next year. An example is henbit.



Henbit



Goosegrass

Dandelion

Purple nutsedge

Summer annuals germinate in the spring and complete their life cycle by fall. Examples are goosegrass and barnyardgrass.

Biennials complete their life cycle within 2 years. The plant forms basal leaves and a tap root the first year; the second year it flowers, matures and dies.

Perennials are weeds that live for many years. They may be divided into simple and creeping. Dandelion is a simple perennial. Purple nutsedge is a creeping perennial, spreading by underground roots as well as by seed.

Weed control methods

Biological. Animals, birds and insects sometimes are used for biological weed control; however, few weeds are controlled adequately. The flea beetle has been used to control the alligator weed that has invaded drainage and irrigation ditches on the Texas Coastal Plains.

Mechanical. Hand pulling is the oldest method of weed control. Other mechanical methods are hoeing, mowing, cultivating and other tillage operations.

Cultural. Crop rotation, competition and good management are cultural weed control methods. A dense, vigorous crop can compete against most weed growth.

Chemical. Chemical weed control has grown in use and popularity since the advent of 2,4-D in the 1940s. There are now about 140 herbicides used for weed control.

Factors affecting chemical weed control

Plant. A seedling grass plant has its growing point below the soil surface. Control is more difficult when the growing point is protected in this manner. Creeping perennial grasses, such as Johnsongrass, have protected buds below the soil surface.

Seedling broadleaf weeds in contrast to grass weeds have an exposed growing point at the top of the young plant. Broadleaf weeds have growing points in the leaf axils of the larger plant. Herbicides are absorbed from post-emergence treatment and move quickly to the growing points for control. Perennial broadleaf weeds have many buds on the creeping roots. Effective herbicides must translocate into the creeping roots for control.

Bulbs and tubers have vegetative parts capable of sending up new growth. Purple nutsedge and wild onion have these underground structures.

Annual weeds have four stages of growth:

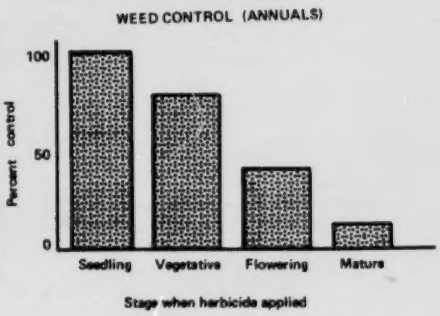
- Seedling
- Vegetative

- Flowering
- Mature

The seedling growth stage is the same for annual, biennial and perennial weeds. They all start from seed. Less energy is required for weed control at the seedling stage of growth than at any other stage of growth. The perennial and biennial seedlings must be from seed and not from underground structures. This is true whether the energy is mechanical, chemical or cultural.

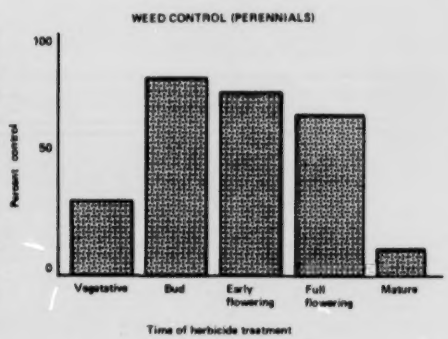
During the vegetative growth stage, the weed is using energy for growth. Control at this stage is still feasible but more difficult than at the seedling stage. During the flowering stage, most of the weeds' energy goes into the seed. At this stage, control for grass and broadleaf annual weeds is only feasible to prevent weed seed maturity. Most weed competition has already been exerted against the desired plant or crop.

Almost 100 percent control is obtained at the seedling stage. At the vegetative stage, control drops to approximately 75 percent, and at the flowering stage, it goes below 40 percent. Little control is obtained if herbicides are applied at the mature stage.



Part of the energy used to produce stems and leaves for the vegetative growth stage of perennials is derived from the energy stored in the underground root system. Other energy comes from the plant leaves. At a certain point, most of the energy of perennial weeds goes into the production of flowers and seeds.

Long term control of perennial weeds treated at the vegetative stage is poor. Control at the early flowering stage almost equals the control at the bud stage, and control is very poor at the mature stage. Apply herbicides to perennial weeds at the bud stage for effective long term control unless the herbicide is labeled differently.



Herbicides applied to weed foliage must penetrate the leaf surface to give control. Wax and cuticle thickness influences the entrance of a herbicide into a leaf. Spray is in good contact on leaves with thin cuticle and wax, but spray will bead up on a leaf with thick cuticle and wax.

A weed leaf with hair on the surface is more difficult to wet because the spray droplet will stand up on the hair. Surfactants used in herbicide sprays reduce the surface tension and increase the spreading of the spray.

Soil

Herbicides may collect on the soil surface from treatment on weed foliage. Other herbicides are applied to the soil surface. Soil type and its influence upon herbicide movement are important considerations. There are two important soil factors.

Soil texture—sand, silt, clay content and organic matter

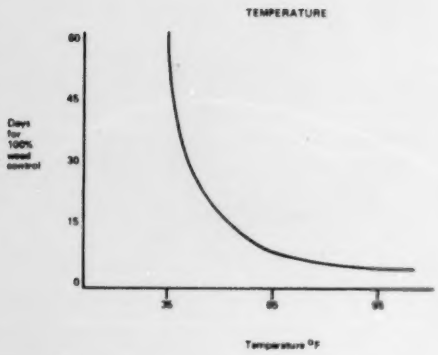
Few herbicides at low rates are used in sandy soil because sand particles and the herbicide do not have strong attraction. The herbicide moves deeper into the soil profile under rainfall. The herbicide and the clay particle have attraction. Thus, it is tied up on the clay particle and will not continue moving through the soil profile under rainfall.

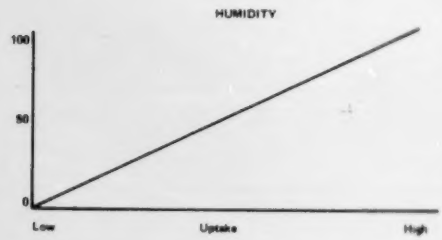
The herbicide moving through the soil is tied up by organic matter and remains near the soil surface. Organic matter and water, sodium, calcium and ammonia also have strong attraction. Higher herbicide rates are used in soil with clay and organic matter because the herbicide tied up on the soil is not readily available for weed control.

Herbicide activation

Water is used to activate soil-applied herbicides. An application is made and either irrigation or rain leaches the herbicide into the soil surface.

Soil incorporation by rototilling is another method of herbicide activation.





Climatic factors

Temperature. It influences the quickness of effect from some herbicide treatments.

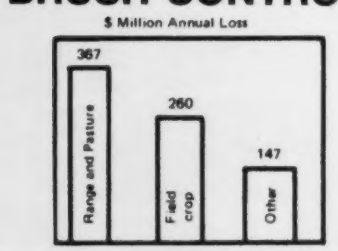
At 35°F about 60 days are required for 100 percent control; whereas, at 65°F 2 weeks are required and at 95°F only a few days are necessary.

Humidity. As the humidity increases from 0 to 100 percent, uptake of a herbicide increases from low to high uptake.

Summary

Be sure of weed identification. Determine the season of weed growth. Know the crop or area infested with weeds. Use a selective herbicide for the weed and apply the correct amount for control at the proper time.

BRUSH CONTROL



Brush infests 88 million acres of Texas grassland, reducing potential livestock production by 50 percent and causing an annual loss of more than $367 million. Proper control methods are necessary to restore the natural rangeland resource.

Wildlife such as deer, quail and other game animals and fish use rangeland natural resources, and plans must be made to improve or maintain their habitat. Livestock, game animals and

recreation can be planned so that the long term brush and weed control program will benefit each and produce the greatest return from natural resources.

Brush species common to Texas vary with the state's geographic area. These include the common persimmon in East Texas to mesquite in the Rolling Plains, creosotebush in far West Texas and the mixed brush species of South Texas which include granjeno, huisache and twisted acacia. All noxious plants either stink, stick or are poisonous.

Brush reduces utilization of the rangeland resource. Areas that were once open savannahs of oaks and grasses will become dense underbrush limiting stocking rate and reducing wildlife habitat if over grazed.

As with insects, plant diseases, weeds and vertebrate pests, correct identification of the brush species is an essential element in developing control measures.

Control may be obtained in several ways, including biological, mechanical and chemical.

Knowledge of the biology and physiology of the brush species is helpful. For example, most woody plants have buds that grow when tops are removed. Thus, the hand axe, the oldest control method, is also the least effective.

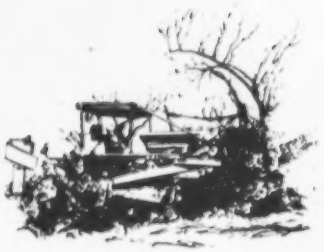
Mesquite has a ring of buds around the root 4 to 8 inches below the soil surface which sprout when the top is killed. Many woody plants are root sprouters such as Texas persimmon, lotebush and macartney rose.

Chemical control is accomplished with herbicides. One can choose liquid or pelleted formulations to control many brush species. There is also a choice of application method. For areas with more than 125 brush plants per acre use a broadcast control method while areas with fewer than 125 plants per acre are suited for individual plant treatment method. Basal pour of kerosene or diesel oil is the oldest and one of the most effective chemical control methods for mesquite and huisache. To be effective, the soil must be dry so the oil can penetrate to the bud zone.

Trunk basal application of some herbicides can be used at anytime except when plants are leafing out or going dormant. Success of the treatment is best when the soil is dry and the solution can penetrate the soil surface.

Cut surface methods of stump and frill can be used successfully anytime during the year. The herbicide solution can be applied with a sprayer or tree injector. The tree injector method is ideal for timber stand improvement.

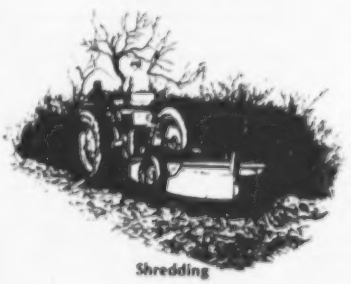
Pelleted formulations of herbicides are applied best when



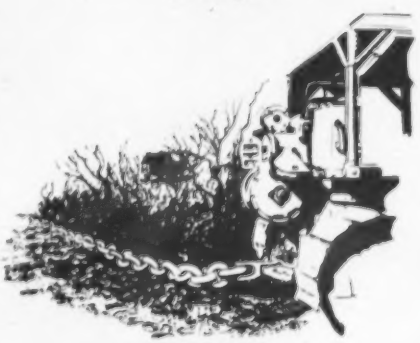
Root plowing

Bulldozing

Mesquite with ring of buds

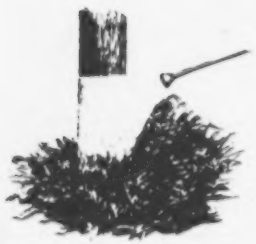


Shredding



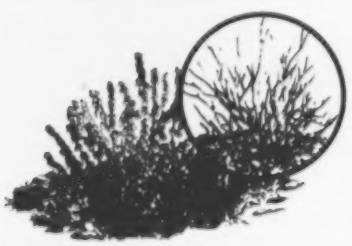
Chaining

Basal pouring of oil

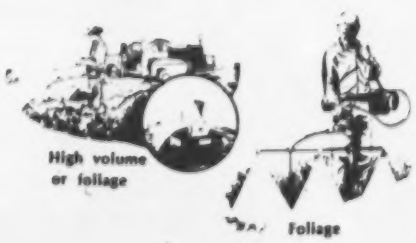


Spraying on trunk base

Spraying cut stump



Soil surface

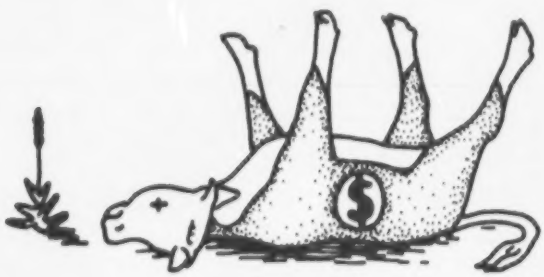


plants are dormant. Rainfall is required to move the herbicide into the soil and in contact with the plant root area.

Apply foliage-wetting spray after plant leaves are fully developed in the spring. Plant leaves and stems must be covered thoroughly with herbicidal solution for satisfactory plant kill.

Spray herbaceous weeds when young and less than 6 inches tall.

Some weeds such as the threadleaf groundsel are toxic to grazing animals. These plants are controlled best with chemicals in the spring when young or in the fall after new growth following rains.



It is important to remember that livestock sometimes graze poisonous plants following a herbicide application. Keep livestock out of sprayed areas until all plants are dead and forage plants have added growth.

High producing, native forage plants reestablish rapidly following herbicidal control of broadleaf weeds. Properly timed chemical weed control allows bird food-producing weeds to grow, which is an important environmental consideration.

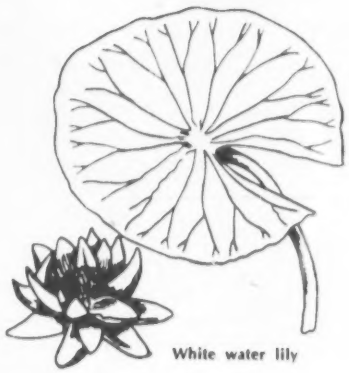
Physical spray drift from the target area is hazardous during herbicide application on grasslands or croplands. Drift can be reduced if applications are made when wind velocity is less than 5 mph, temperatures are under 95°F and drift control additives are used that can be added to the herbicide solution to increase droplet size. Drift control additives also serve as wetting agents.

Infestation of woody and herbaceous plants occurs following initial control. A long term brush and weed control program with maintenance control of reinfesting plants must be followed for a properly balanced plant community and best use of all natural resources.

Brush and weed control using proper methods combined with good grazing management will maintain the natural resources for livestock production, wildlife habitat and recreation.

AQUATIC VEGETATION CONTROL

Identification is the most important requirement for successful aquatic vegetation control. Most control methods are aimed at specific weeds or groups of weeds. Emersed aquatic plants grow up out of the water or along the edges of ponds or lakes. These include cattails, bulrushes and arrowheads. Submersed aquatic plants grow under the water although they may have leaves that come to the surface of the water. Bushy pond-weeds, coontail and milfoil are in this category. The entire plant or only some of the leaves of floating plants rest on the water's surface. Examples of these are duckweed, water hyacinth and water lilies. The fourth type of weed, and one that poses many problems in Texas, is the algaes. These are weeds without true stems, leaves or vascular systems. Examples are the phytoplankton which gives the green color to water, the filamentous algae such as pond scum and the branched or higher algae such as muskgrass. Most of these plants are troublesome in some situations and beneficial in other situations, depending upon their abundance and how the water is used where the plants live.



White water lily

The most important factor in controlling or preventing aquatic weeds is proper design and construction of ponds. Shallow water at the edge of ponds provides ideal habitat for weeds such as cattail and also is conducive to algae growth. Banks should be sloped allowing a minimum of water less than 3 feet deep. Sometimes it may be necessary to use mechanical control to rid the pond of submersed weeds. Disposing of mechanically harvested weeds is usually a problem. Most mechanical control methods also fragment the weeds which may actually encourage spreading since weeds will reproduce from fragments. Mechanical control is usually slower and much more costly than chemical control.

Watermilfoil

Another method of mechanical control is to drain and dry the pond. The season of the year and the species of plants present may determine whether this method will be useful in a particular situation. Also, you must consider the existing fish and their normal spawning time before draining and drying.

Use of fertilizer is usually considered mechanical control. Fertilization stimulates the growth of microscopic algae which in turn shades the bottom and prevents or reduces growth of submersed weeds. Ponds with a high rate of water exchange usually do not respond well to fertilization.

Biological controls also may be used. These may include herbivorous fishes such as the tilapia. An introduced species, tilapia will not survive winter temperatures in most parts of Texas unless there is a hot water discharge. Other biological controls include insects, but very few have proven effective even though many insects are currently being studied.

Chemicals used in aquatic weed control are available in several formulations. These include liquid and granular formulations,

Waterweed

Bushy pondweed

Water hyacinth

emulsions and invert sprays. Emulsions are used for those herbicides which are not water soluble. Granular herbicides are used for spot treatment when it is necessary to get the herbicide to the root of the plant and build up a herbicide concentration in a localized area. Liquid herbicides are used when it is necessary for the chemical to be dispersed evenly throughout the water to bathe the entire plant in the herbicide solution.

Application techniques also are important in treating aquatic vegetation. For plants which grow to the water's surface, a surface treatment is adequate. For submersed plants, a total water treatment normally is required. Whenever a total water treatment is contemplated, consider the toxicity of the chemical to fish or other aquatic organisms. Another approach involves treating soil in the drained pond or lake. This is quite effective and usually requires much less chemical.

To control floating and shoreline vegetation, chemical amounts are computed on a per acre basis.

For treating submersed weeds or algae, it is usually necessary to calculate the total water volume in acre feet. An acre foot of water is defined as 1 acre of water 1 foot deep.

Weed control in flowing waters, however, is most difficult. Herbicides applied may flow out of the pond and into streams causing possible damage to crops irrigated with the water. Some chemicals also may cause a problem with domestic, industrial or recreational waters. To preclude damage, it is best to read the label carefully and investigate the possible use of the water after it leaves the treatment area. Aquatic vegetation control involves identifying the weed and using only those chemicals which are cleared for use on particular weed species.

Incorrect application of herbicides, fish toxicants or insecticides to water may involve serious hazards to man, fish, desirable plant life, wildlife, adjacent crops and livestock.

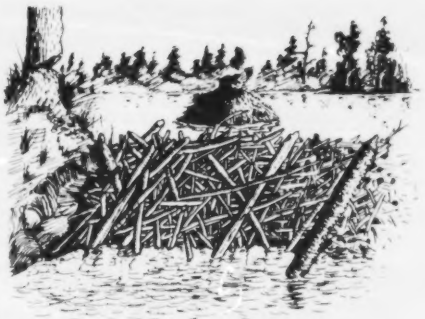
Each chemical that is to be applied should be checked carefully for restrictions before it is used. Some chemicals cannot be used in ponds where fish are to be grown for food. Other chemicals cannot be used when the water is intended for human consumption. Many chemicals cannot be used in water intended for subsequent irrigation. Thus, the control of aquatic vegetation does present special problems because waters often have multiple uses and herbicides will not always remain where they are placed.

Excessive or inappropriate chemical applications can cause damage from direct toxicity or suffocation from an excessive or rapid kill of plant materials which deplete the oxygen supply. Bacterial contamination is a secondary problem resulting from dead fish decay which contaminates downstream water supplies. Water may not be fit for irrigation or human consumption, and it may be necessary to restrict livestock from using the water for a while.

WILDLIFE DAMAGE CONTROL

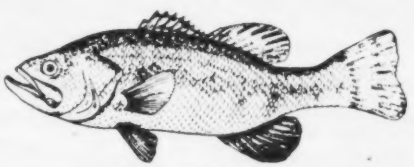
The objective of wildlife damage control is to prevent or reduce conflicts caused by the presence of wildlife — **not to destroy wildlife.** Many problems of wildlife damage may be solved by applying preventive control such as sanitation, and this should be the primary goal. However, there will always be problems and situations where reduction of animal numbers will be necessary.

Wildlife is a public-owned resource protected by numerous federal and state laws. Before any wildlife damage control program is begun, the legal status of the animal should be determined since the laws will influence the selection of techniques to be used. Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service are the state and federal regulatory agencies to contact about laws related to wildlife protection.



Beaver dams flood bottom lands

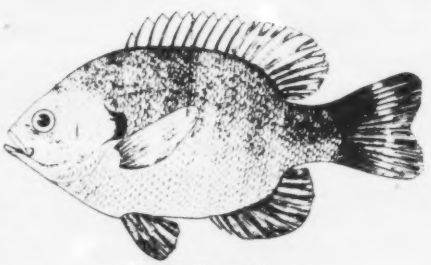
Man experiences problems with naturally existing wildlife populations because both depend upon the same resources. Since wildlife does not recognize human ownership of a resource, the possibility of conflict will always exist. For example, cormorants will catch and eat farm-reared fish just as readily as they will catch and eat wild ones.



Largemouth black bass

Man may improve living conditions for some wildlife by planting crops which become food and cover for those species. Cotton rats may populate a peanut field because it is favorable to them with resulting damage to the peanuts.

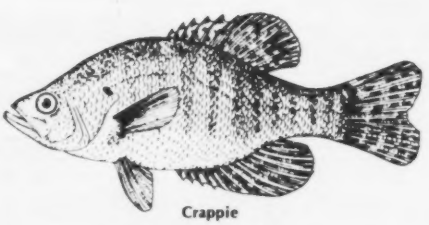
Man may create favorable conditions for some animals through normal cultural practices such as grazing on rangelands or harvesting a forest. Ground squirrels are favored by livestock grazing.



Bluegill sunfish

Gopher damage to seedling trees following timber harvest is possible because of increased gopher numbers. Problems develop because the gophers, while feeding on grass and weed roots, also eat the roots of newly planted tree seedlings.

In any given situation, one or more wildlife species including mammals, birds, reptiles, amphibians or fish may conflict with man's interest. Under favorable conditions, some wildlife populations may increase to problem levels.



Crappie

Some fish species are considered pests in certain situations. There are certain fish which compete with desirable fish for food, space or other necessities of life. Another might be those fish that affect the crop you have in the pond or ones that feed on the more desirable fish. Controlling pest fish varies with every situation, every species and with the use intended for the desirable fish. Though some fish may be pests at certain times, they may also be protected game fish, such as largemouth bass. Nonchemical control includes draining ponds or using physical barriers such as traps, nets or barrier dams. Chemical control should be investigated carefully so that desirable species are not affected. Chemicals are available which are selective against certain species of fish, and

Rodents frequently causing pest situations

Armadillo

Fox

Raccoon

Opossum

Animals commonly found near man

other chemicals are available which remove all fish from a particular body of water. Just as in applying herbicides or insecticides to a particular body of water, the use of fish toxicants should be planned and monitored carefully so that there is no danger of chemical escape which might harm other streams or lakes in the vicinity.

Nutria, a large rodent, is a valuable fur resource in coastal marshes. However, in fresh water impoundments, rice fields or farm ponds, its denning activities damage levies and dams. Rodents are most frequently associated with problems because there are many species which are highly productive and widespread.

Many pest control techniques are needed for handling wildlife damage because each situation presents some unique aspects. A combination of techniques involving more than one approach may be needed to handle a complex situation such as coyote predation on sheep or deer damaging truck crops.

Techniques of wildlife damage control might be categorized under three broad approaches: environmental modifications, repellents and population reduction. Such variables as species causing damage, crop to be protected, season of damage, damage duration, legal status of wildlife, biological characteristics of the nuisance animal and species behavior influence the choice of a technique.

The presence of an animal capable of causing damage does not always require control. It is not easy to determine when control is necessary. While very obvious at times, objective data are difficult to obtain in particular problems. Professional help at this time may be advisable to save unnecessary labor and costs. The control level must be balanced with cost, effort and the value of the goods preserved.

Some animals may be seen on the fields before damage is noticed. But, it is important to determine first if there is damage and, if so, to examine it closely. Obvious animals may not be causing a problem. Avosets and willets are frequently seen in wet fields along the coast. They and other wading birds probe the mud of newly flooded rice fields. However, many consume insects, crustaceans, brine shrimp and other small aquatic life, not seeds such as rice.

Biological characteristics differ between groups of animals. The first step in solving a wildlife damage problem is identifying the species involved. Controlling beaver damage requires a different approach from nutria control, although in some cases their damage is similar.

Since most mammals are active at night, their damage may become extensive before any animals are noticed. Species causing

problems must be identified from circumstantial evidence at the site of the damage. Tracks are usually characteristic for an animal.

Fecal materials or scats are distinctive for some animals, such as nutria. By using all evidence including rubs, hair, tooth marks, scats, feathers and tracks, a careful observer can make an accurate identification.

Dark crescent-shaped markings near the rafters indicate the presence of roof rats. Roof rats move high in buildings rather than along or under the floor like Norway rats. Pesticides must be placed correctly for the pest animal concerned.

All wildlife requires food, cover, water and space, and the place where the animal lives must supply these needs. Environmental control is making the environment inhospitable by removing one of these essentials. Generally this produces the most lasting effect. Since considerable time may be required for environmental manipulations, problem situations must be anticipated to avoid conflict.

Duration and season of the damage impact are important in determining the degree of control needed. Protecting tree seedlings from deer browsing may be necessary for 6 months during each year for a decade while protecting corn from blackbirds is only needed for 2 to 3 weeks in the spring. Different techniques are dictated by the time interval.

Repellents are used to change animal behavior. The repellents can be applied rapidly after a damage situation is identified; however, results are highly variable depending upon the skill of the applicator. It is important to begin control procedures as soon as possible, even before damage begins. After feeding habits are established firmly, the animals are difficult to displace.

Repellents depend upon producing an adverse response in animals through one or more of their senses. They may be categorized according to the sense which is affected: hearing, sight, smell, taste or touch.

Taste repellents require animals to consume a portion of the protected crop to taste the repellent. Many chemicals taste bad and repel animals, but they may leave a residue on the crop that is not removed easily from edible plant parts.

Seedling damage may be difficult to prevent with taste repellents. The taste repellency of a chemical differs between species of animals so the correct repellent must be used to achieve positive results. Taste repellents are difficult to use on rapidly growing plants because of animal's habit of feeding on the newest growth, perhaps not consuming the chemical.

Repellents to the sense of smell have been used a long time. Foul smelling concoctions have been used to frighten everything

Nutria

Beaver

Coyote

Red fox

Dog

Red-winged blackbird

Brown-headed cowbird

Starling

from deer to evil spirits. Volatile materials usually have a short life, necessitating frequent applications. Susceptibility varies greatly between animals.

Of newer origin are the physiological repellents. This type of repellent has been used to protect sprouting corn from pheasants. These chemicals, when eaten, act through the nervous system causing an unpleasant experience for the animal. With solitary animals, each individual must learn what to avoid. Therefore, some damage will occur during the learning period.

In highly social animals, such as blackbirds, distress in some members of the group is communicated to the entire group, and the group responds. A different approach may be used. The physiological repellent may be a toxic material given in lethal doses. But, only a very small fraction of the flock receives the treated bait with the remainder receiving untreated bait. Thus, a few animals are sacrificed to drive away the remainder of the group.

The third approach to reducing wildlife damage is to directly reduce the population of offending animals. This usually means using lethal techniques. Vertebrate pesticides are seldom selective; therefore, the applicator must limit the effects of use to the target animals through his knowledge of the animals' behavior and feeding habits.

A method used to reduce an animal population in a particular situation is usually determined by its legality, efficiency, economy and ability to affect only target animals.

Population control might be considered in three levels each with somewhat different objectives: selective removal of individuals, general population reduction and suppression and population extermination.

Selective removal of individuals causing damage has the least environmental impact. However, it requires a good knowledge of the species life history and behavior and/or a highly selective technique. It is used where considerable damage is caused by few animals, such as a coyote in a turkey yard. Being selective usually means expending considerable effort per animal removed.

Lethal techniques must be applied diligently to achieve any significant reduction in species with high reproductive potential or only a cropping of the surplus will occur. In fact, removing surplus animals may stimulate greater reproduction and compound the problem. This compensatory mechanism common to many vertebrate species necessitates controlling reproduction.

Populations also may be reduced or controlled by suppressing reproduction chemically. Chemosterilents are presently available for use in pigeon control. Though the technique is too new to have

widespread application, it offers a desirable option to destroying existing animals.

Extermination or eradication of a group of animals over a large area is very seldom a worthwhile or achievable objective. However, eradication in some instances, such as gophers in a field, is appropriate. Commensal or domestic rodents are perhaps the most commonly occurring examples.

Pesticides for vertebrates may be received via a number of ways: ingestion (eaten), absorption (through the skin) and inhalation (breathing). This offers several possible means of reaching target species and excluding others.

Pesticides which are eaten usually are presented with a bait or water, making bait selection important. Season of the year, availability of other foods and acceptability to target and nontarget animals are considerations in choosing bait. It must be highly acceptable, or bait shyness may develop. The pesticide must be capable of being hidden or must be acceptable to the animals involved. Target species may be repelled by odor or taste of the chemical.

Pesticides acquired by absorption are limited in use because of hazards to other species or because of the difficulty in presenting the chemical to the target animal. Tracking powder used with domestic rodents is probably the most common example.

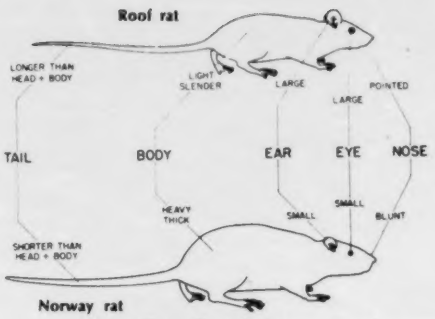
Pesticides which are inhaled also are rather specialized. Fumigants usually are limited to use with animals in close confinement, such as burrows or buildings. They are effective in treating Norway rat burrows.

Some pesticides present hazards of secondary poisoning. Therefore, carcasses of treated animals must be collected and destroyed. Control of some animals may expose the applicator and others in the vicinity to external parasites which could be disease carriers. Treatment to kill the parasites before vertebrate control is advisable.

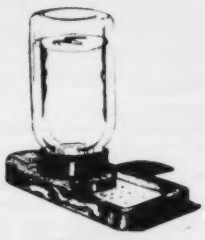
Principles of wildlife damage control might be summarized by:

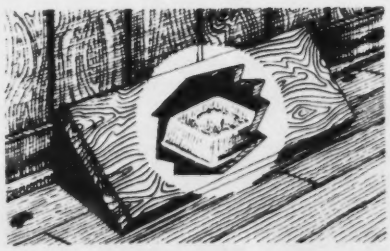
- Recognizing damage patterns and the species responsible
- Knowing the characteristics and life habits of the species
- Knowing available control measures
- Knowing regulations
- Evaluating risks versus benefits

The identity of most, if not all, pests encountered in your farm and ranch operation is well known to you. However, should you



Domestic rodents


Bait and water poisoning



Inhaled fumigants

ASSISTANCE

encounter a stranger, assistance is available; your county Extension agent is one source of such help.

He has several sources of information to aid and assist in the accurate identification of a pest problem, including:

- Publications
- Extension specialists in the various subject matter areas
- Private industry consultants
- Pest diagnostic laboratories and services
- Rodent and Predatory Animal Control Service

These sources compliment the Extension agent's own knowledge of county pest problems gained through personal experience in helping producers solve pest problems.